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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN, THE NATIONAL IRONFOUNDING EMPLOYERS' FEDERATION, THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES' EQUIPMENT AND SUPPLIES ASSOCIATION

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Forthcoming Events

FEBRUARY 15.

Institution of Welding Engineers (North-Eastern Branch):—Meeting at Neville Hall, Newcastle. "Steelmaking as applied to Welding," Paper by H. Bull.

Institute of British Foundrymen

FEBRUARY 16.

Sheffield and District Branch:—Meeting in Grand Hotel, Sheffield, at 7.45 p.m. "Alloy Pig-Irons," Paper by J. H. D. Bradshaw.

FEBRUARY 17.

East Midlands Branch (Lincolnshire Section):—Meeting at Technical College, Lincoln, at 7 p.m. "General Foundry Practice," Paper by J. Sherwood.
Lancashire Branch:—Meeting at Engineers' Club, Manchester, at 4 p.m. "The Production of Specially Hard Cast Irons by Alloying and Heat-Treatment," Paper by F. W. Griffiths.
Wales and Monmouth Branch:—Meeting at University College, Cardiff, at 6.30 p.m. "Coke and its Use in Modern Foundry Practice," Paper by E. Wautier.

FEBRUARY 22.

Lancashire Branch (Junior Section):—Meeting at Engineers' Club, Manchester. "Foundry Progress during the past Thirty Years," Paper by E. Flower.

FEBRUARY 24.

East Midlands Branch:—Meeting at the Technical College, Derby, at 6 p.m. Lecture by H. E. Beardshaw.
Newcastle and District Branch:—Meeting at Neville Hall, Newcastle, at 6.15 p.m. "The Work of the Institute's Technical Committee," Paper by A. Logan.
Scottish Branch (Edinburgh Section):—Annual general meeting in the Heriot Watt College, Edinburgh, at 4 p.m. "The Foundry Cupola," Paper by R. S. M. Jeffrey.

Scientific Instruments

Feeling that the daily-increasing scientific control of materials and processes in industry is largely bound up with the use of instruments of various kinds, for the measurement, both by indicators and recorders, of pressure, temperature, and so forth, we recently paid a visit to the annual exhibition of scientific instruments and apparatus held by the Physical Society. The January exhibition was the twenty-fourth, and it must have grown amazingly during that period. At any rate, speaking without inside knowledge of the way the show is organised, we came to the definite conclusion that it is now too important and too large for the Imperial College of Science and Technology, which has so hospitably housed it hitherto. We are aware that difficulties exist for scientific societies who arrange exhibitions, but for the visitor it is rather trying to see quickly and easily a group of exhibits so variously distributed, and even so far from central London as South Kensington. There were over eighty trade exhibits and a score of contributors, research associations, hospitals, individuals and firms, to a research and experimental section embodying new apparatus. There was a wholly admirable scheme of prizes for encouraging craftsmanship and draughtsmanship among apprentices and learners. The examples, cognate to the trade, covered both metal-working and patternmaking. There were evening lectures. The catalogue is a well-printed and clearly-arranged production which sets the average exhibition catalogue to shame. It had two excellent features. All new exhibits, that is, apparatus and instruments shown for the first time, were marked by an asterisk, and the actual exhibits were marked with a red star. Secondly, all exhibits shown or capable of being shown in actual operation were duly marked in the catalogue. Foreign instrument makers were apparently not restricted, but we thought that the home makers put up an admirable group of exhibits. Naturally the foundry industry would have been interested mainly in the optical exhibits, metallurgical microscopes and their cameras, in exhibits by the laboratory suppliers, and in appliances for air measurement and temperature measurement. We suggest that, in future, exhibitions should be made better known to industry as a whole. New visitors would be attracted and not improbably new exhibitors.

Sand Control

It is to-day just as important to control the condition of the sands in a foundry as it is to regulate the composition and temperature of the molten metal. The primary requisite is cleanliness, and even the smallest foundry can at least provide waste-paper baskets to ensure that the sand is free from orange peel, cigarette cards, silver paper and similar discards. The next contamination is spillings, and the obvious means of ridding the sand from iron is by a magnetic separator, but this is, unfortunately, often difficult for the foundry executive to obtain sanction to buy. The best method available for keeping the sand clean under these conditions is to have a labourer following the teemers with a shovel and barrow and removing as much as possible whilst they are still readily visible. Then all the backing sand should go through a riddle. This is the very minimum requirement for even a small jobbing foundry, viewed in the light of modern practice.

The next step is to know something of the properties of the sands in daily use, so that if a period of trouble is experienced one at least knows exactly what is standard practice in one's own works. Such information is extremely helpful to the manager or foreman in obtaining for his department some of the excellent new plant which is available for the milling, aeration and general reconditioning and distribution of moulding sand. We find at the present time that many managers are not satisfied with their sands after seeing and handling the wonderfully fluffy, clean standard production current in the more modern foundries, yet they possess not one single figure—even moisture content—of the sands they are using. In discussing with their colleagues or managers from other establishments, they can only call upon their limited descriptive ability to express the nature of the bulk of the sands used. For facing sands a somewhat better approximation can be conveyed verbally, but even this is still bound to be somewhat sketchy.

Where sand control has been instituted, it has proved to be a distinctly paying proposition, whether of the simplest character or involving almost a reorganisation of the methods used in the foundry.

XUM

Correspondence

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

The B.I.F. Patents

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—In view of the forthcoming British Industries Fair, I wish to draw the attention of your readers, many of whom may be exhibitors, to the danger of taking advantage of Sections 45 (1) and 59 (1) of the Patents and Designs Act.

Under these Sections an unprotected invention may be exhibited provided the Comptroller is notified on the prescribed form. An Application for Patent may be filed for the same invention within six months of the date of the opening of the Fair. However, no priority of date is given, and anyone seeing an invention may file an Application for Patent in this country and other countries, and unless the first and true inventor can prove fraud, the applicant will obtain a valid patent.

A well-known patent Counsel, in his evidence before the Commission presided over by Sir Charles Sargeant, dealt with this matter and endeavoured to have the Sections of the Act strengthened, but without success.

The importance of this matter to exhibitors at the British Industries Fair cannot be overestimated in view of the "international" attendance.—Yours, etc.,

G. DRURY COLEMAN,
General Secretary,
Institute of Patents.

39, Victoria Street, S.W.1.
January 25, 1934.

Oil as Fuel

At a meeting of the Chemical Section of the Manchester Literary and Philosophical Society, presided over by Mr. L. M. Angus Butterworth, F.R.G.S., Mr. J. Galloway Walker, M.I.Mech.E., of Crossley Brothers, reviewed the potentialities of oil as a fuel for both internal and external combustion. When dealing with heating furnaces, Mr. Walker said that oil-heated furnaces had the advantage over coal-fired furnaces in being more quickly put into service and in the avoidance of all standby losses. The attention required was very small and temperature regulation could be adjusted within fine limits. These same advantages to a large extent could be claimed for gas-heated furnaces, but, generally speaking, town gas was much dearer compared with fuel oil for the equivalent number of heat units. A typical case would show that cost of 100,000 heat units would be 5d. for gas and 2¾d. for fuel oil.

Canadian Copper

Copper production amounted to 300,978,523 lbs., valued at $21,646,000, an increase of 22 per cent. in quantity and 42 per cent. in value over the previous year. With five large copper producers and with excellent refining facilities in Ontario and Quebec, and an export market which has been built up through the excellence of the product, the increase in output readily reflects the improved conditions in the countries to which Canada sells.

Canadian Nickel Output

Nickel production in Canada last year amounted to 84,586,300 lbs., worth $20,736,000, as against 30,327,968 lbs., valued at $7,179,862, in 1932. In January, 1932, nickel output totalled only 1,780,899 lbs., but with the exception of April, increases were recorded each month, with June showing a marked improvement over May, and October (the last month for which monthly statistics are available) recording an output of 10,714,020 lbs.

Institute of British Foundrymen

PRESIDENT OF THE JUNIOR SECTION, LANCASHIRE BRANCH

Mr. R. A. Jones, of Pendlebury, is now in his second year of office as President of the Junior Section of the Lancashire Branch of the Institute of British Foundrymen. During his term of office he has well maintained the high standard set by his predecessors in office. The works visits have been well arranged and the quality of the lectures given at the Branch meetings has been excellent. On the occasions of their summer outings the members of the Junior Section have been entertained by Mr. Jones. He has greatly stressed the social development of the Section and their annual social evenings have been great successes. Due undoubtedly to the very bad state of trade in the Lancashire district, the affairs of the Junior Section have been difficult, owing to lack of members, but the great personal interest shown by Mr. Jones has been of considerable help to the other officers, who are working for the success of the Section.

MR. R. A. JONES.

Mr. Jones served his apprenticeship with Messrs. W. & J. F. Jones, Limited, Pendlebury. He studied engineering at the Salford Royal Technical College and later metallurgy at the Manchester College of Technology. In 1926 he became manager of the firm, and in 1928 managing director.

Book Review

(Concluded from next column)

dictionary. Separate parts can be obtained at prices varying between 6 and 16 R.M. A brochure setting out the contents of the various parts has been issued by the publishers. It is interesting to note that Volume 2 (in preparation) will deal with pig-iron, cast iron, chilled iron and malleable cast iron. The publication of this volume will be looked forward to with interest by foundry metallurgists. It is proposed to complete the work by publishing four further volumes dealing with non-ferrous metals, a truly stupendous task.

F. K. N.

Book Review

Atlas Metallographicus. Vol. 1. "Carbon Steels, Slowly Cooled and Annealed," by H. HANEMANN and A. SCHRADER. Published by Gebrüder Borntraeger, Schöneberger Ufer 12 a. Berlin W 35. Price 128 R.M. Bound in half leather.

The first seven parts of this atlas of metallography have already been reviewed in these pages, and it will be recalled that they cover the crystalline structures met with in carbon steels from the point of view of fracture, macrostructure and microstructure. The structures have been photographed by means of special colour-sensitive plates and reproduced by a special direct-printing process giving unusually clear definition in warm, light brown tones. A certain amount of explanatory matter accompanies each section of the work and each microstructure illustrated is accompanied by details of composition, treatment, etching, magnification and description of structural features. In all, the work contains 823 microstructures on 108 loose plates.

The parts now under review (Parts 8-14) continue the previously-published structures and Part 8 deals with the influence of carbon content and rate of cooling on the structure of steel. The development of granular, network and Widmannstätten structures are clearly shown, and also the dependability of the amount of free ferrite and corresponding carbon content of the pearlite on the cooling rate. The various formations of pearlite in both hypo-eutectoid and hyper-eutectoid steels are also illustrated, together with the formation of cementite network in hyper-eutectoid steels. Part 9 is mainly confined to the influence of normalising and annealing on the grain size, pearlite formation and pearlite decomposition of carbon steels mostly of the eutectoid and hyper-eutectoid class. This section is naturally of great interest to those concerned in the heat-treatment of steel. The subject is continued in Part 10, which illustrates the influence of cooling rate on such steels. The influence of similar treatment on hypo-eutectoid steels is also dealt with, and particularly the changes which take place in very low carbon steels. Part 11 deals with the formation of iron nitride in mild steels, and also the influence of cold work, illustrating slip bands, twinning and grain distortion. The structures developed by Fry's reagent on tensile test-pieces are illustrated. The influence of straining and cold working is continued in Part 12, including examples of the bending and distortion of the cementite layers in pearlite and the fracture of network cementite. The influence of re-heating and cold-worked steels is also dealt with, and in Part 13 the crystal sizes obtained by re-crystallising and normalising are shown. One plate shows the influence of re-heating on the crystal structure immediately below a Brinell impression. The behaviour of steels as regards "flow" is also illustrated, including structures from impact, piercing, torsion and compression test-pieces. Part 14 completes the volume with structures of steel wire in various stages of drawing. A complete index with cross references for the whole volume is included in this part.

The magnitude of the work precludes detailed description or criticism, but there is no doubt that the work as a whole constitutes a remarkable collection of structures which are invaluable to all interested in the study of steel. The work is published in German, which may offer difficulties to the English reader as regards the general text, but it should be pointed out that each plate of microstructures is accompanied by a tabular key which sets out the principal features in a clear way, and which can be readily followed without too frequent recourse to the

(Concluded in previous column)

Modern Cupola Practice*

By H. H. Shepherd

Introduction

Fundamentally, the cupola furnace has changed little in design or in the general principles of operation since its inception nearly 200 years ago by that remarkably-clever British engineer and foundryman John Wilkinson, and it stands as a practical monument to his memory in, at least, 95 per cent. of the world's iron-foundries. In these days of rapid progress people are a little too quick to condemn "old fashioned or out of date," as they are called, ways, methods, plant and equipment of industrial and domestic life.

Consider progress in the ironfoundry world. Tremendous strides have taken place in all branches of foundry practice; probably the greatest progress has been made in the direction known as mechanisation, but it is easily possible to over-mechanise, that is, to put costly equipment into certain sections of a particular foundry only to find that manual labour would have been less costly and more efficient.

The same remarks apply to the cupola furnace; from time to time in recent years there have been rumours that the death knell of the cupola has been sounded, but it needs no prophet to foresee the cupola still functioning as the heart of many foundries for many more years to come. Nothing is further from the author's mind than to have any biassed views against the new methods of melting cast iron; they can, and do, produce a very excellent quality at a competitive cost, metal which, for certain castings and under certain conditions of production, leaves little to be desired. However, there remains much in favour of the cupola as an efficient and economical melting medium under almost countless conditions, and high quality castings of all sizes and shapes can be produced if reasonable care is given to its control, whilst the quality could be further enhanced if we are prepared to give as much care to control as is given to other types of melting units. No one will deny the very great economical advantages of a cupola in a repetition foundry, owing to it being so easily possible to obtain continuous operation and without heavy initial capital expenses, even if one adopts the most modern practice.

The Balanced-Blast Cupola

There have been countless inventions and modifications applied to cupola practice for better or worse, but it is impossible to deal with all of those which are successful in a Paper of this kind, but to sum up all the various designs and practices the author has no hesitation in stating that the balanced-blast cupola and the system of its operation devised by Mr. J. E. Fletcher and patented by the B.C.I.R.A. represents the most efficient and economical progress that has yet been made in cupola design and practice.

Crane, Limited, Cupolas

The author has been directly responsible for the operation of two of this type of cupola for nearly two years, and a complete account of the costs, etc., of the conversion of these two cupolas to the balanced-blast system, and the results obtained and the author's experiences after some months of their operation, was given in a Paper read before the Birmingham, Coventry and West Midland Branch of the I.B.F. in December, 1932, and published in THE FOUNDRY TRADE JOURNAL, January 5 and 12, 1933.

The cupolas were converted to the balanced-blast system from a system which previously was considered to represent the most efficient practice, and it is of interest to note that the malleable cupola was the first one making malleable castings to be converted to this system; the other is used in the manufacture of radiator, boiler fittings and other grey-iron castings.

Since the manufacture of cupola black-heart malleable castings necessitates very careful control of all stages in the cupola and metallurgical practice, it is proposed to deal with this particular cupola practice.

Malleable Cupola Design

The cupola consists of a 60-in. shell; the height from baseplate to the charging door is 20 ft. This is appreciably more than some cupolas, and there is no doubt that the extra height accounts for some of the efficiency, such as freedom from flame at the charging door, though it should be pointed out that the balanced-blast system is the most effective means of preventing this, or, in other words, waste heat in the form of high-temperature gases high in CO. The ratio of height (from the bottom of the tuyeres to the charging door) compared to diameter of melting zone is 6.7 to 1. Charges are usually kept down 3 ft. below the charging door, giving a ratio of 5.6 to 1; that is to say, the effective height of the cupola from bottom of the tuyeres to 3 ft. below the charging sill is 15 ft. The shorter this height, the greater the tendency for flames or combustible gases to be present at this height. Too high a coke bed will also give flame at this point. It should, however, be borne in mind that lack of flame does not always indicate efficient practice; it all depends upon the amount of escaping CO gas or, in other words, lost heat units represented by a loss of approximately two-thirds of the available heat units. For example, an ordinary cupola may contain 6 to 10 per cent. or more of CO in its gases at the charging door; the gases from a balanced-blast cupola have been found to contain considerably less than 6 per cent.

The air belt of a balanced-blast cupola is of rather more generous size than is usual, a further point in favour of this system, for such proportioned wind belt results in uniform distribution of the blast to main and auxiliary tuyeres, reduces pulsations and minimises the possibility of tuyeres near the blow-pipe entrance passing more air than the other tuyeres.

The air belt of most cupolas operated by this system is 4 ft. 6 in. deep, but in our case we had to insert the main tuyeres through the belt, and so the belt depth was increased to 5 ft. 5 in. The ratio of the wind-belt area to the blast-pipe area is 2.7 to 1. The wind belt is narrower than the author would recommend for reasons previously explained, but it would have meant additional expense had a larger cross-sectional area belt been fitted. The generally accepted figure for this ratio is 3 or 4 to 1, the higher figure applying to large-size cupolas.

Blowing Unit

The air is supplied by a centrifugal fan and delivered by a 15-in. dia. pipe to the wind belt. The centrifugal fan has come to be accepted as a very efficient means of supplying air blast; such equipment is much cheaper than a blower, and somewhat less costly to run and maintain. It is perhaps safe to say that the fan is the most suitable blowing unit for all but very large size cupolas; this is partly supported by the fact that the positive blower of the Roots type is more in evidence in the large foundries of U.S.A. though, even in that country, the tendency is towards the fan blower. The fan should be of adequate size to give sufficient air, but not excessively over the size; and the driving of it to give its utmost output should be avoided, or excessive coke consumption, lining wear and, maybe, dull iron will probably result. This will be referred to again when considering lining sizes.

The tuyeres comprise four main valve tuyeres and 12 auxiliary tuyeres in rows of four, but in our particular practice only the two lower rows of auxiliary tuyeres are used. The method of operation, etc., has been treated fully in the Paper previously referred to; suffice it to say now that the design of these tuyeres and valves is a splendid engineering job and bears comparison with any piece of engineering and foundry equipment which has yet been introduced into the modern foundry; they give maximum control over the blast, are extremely simple to operate, ensure more uniform distribution of the blast, eliminate scaffolding which is likely to arise from the old type splayed tuyere, and keep so much cleaner that poking is eliminated except in very long melts such as is the case with the author's works. The standard ratio of tuyere area to cupola cross-sectional area at the melting zone is between 1.5 to 1.8, the ratio increasing with increasing diameter.

Lining

The cupola was originally lined to 27 in. for a distance of 7 ft. 3 in. from the top of the wall, and this gave an hourly output of three tons, but increased production led to the opening up of the lining to 32 in. to give about four tons per hr. At this stage the author would like to stress an important point, that is, if it is desired that a cupola should give a greater output, either permanently or for any particular melt, one should make sure that the diameter is in accordance with the output specified; it is a simple matter to calculate what a certain diameter should give, any correctly-operated cupola will melt 10 lbs. of iron per hr. per sq. in. of area; this figure is rather a conservative one, the basis of calculating for the balanced-blast cupola is 0.75 tons per hr. per sq. ft. of bore area at the tuyeres.

To force a given diameter lining to give a much greater output than is the correct output for that size, by blowing hard or excessively, is very bad practice; it results, to mention only two results, in oxidised iron and badly-cut lining, and if you are operating any length of time cold iron will follow. It is good practice to insist that the cupola man uses a gauge stick cut to the diameter specified by the furnace at the melting zone, and it is, of course, necessary to see that where patching finishes shelving in the ganister is avoided, otherwise "hanging" or "scaffolding" will occur.

There seems to be a tendency in many cases of cupola practice to give the furnace a thorough patching at the week-end and very little any day during the week; whilst this may not be harmful to small runs lasting only an hour or so, it is certainly asking for trouble in cases of longer melts extending to 11 or 12 hours or more, as in the case at the author's works. Where a definite average rate of output per hour each day has to be obtained in order to keep in line with a definite average rate of mould production, the cupola output has inevitably to synchronise with the foundry output. Probably many cases of trouble arising with cupola practice can very often be traced to large variations in the diameter after patching; that is, failure to patch to a standard size each day.

Cupola Lining

Quite a lot of facts and fancies have been given out about monolithic linings; some are very successful, whilst some are very expensive failures. However, unless one treats a monolithic lining when it is first put in the cupola, like a raw fireclay mixture, by giving the lining a very careful drying and firing extending over several days before it is put into practice, it will be found that such linings are a failure. Personally, the author prefers the cupola brickmaker to provide a properly-tried and firedbrick, for one reason that his practice does not allow

* A Paper read before the Lincolnshire Section of East Midlands Branch of the Institute of British Foundrymen, Mr. Walters presiding.

time to give the necessary treatment that a monolithic lining requires. That the management is satisfied with this practice is borne out by the fact that the firm uses one cupola day after day, not on alternate days, as is the usual practice, and each melt extends over 11 to 12 hours per day, at a rate of 4 tons per hour, or an average of 45 tons per day; the cupola is repatched with ganister and 1-in. firebricks during the night, and is relined with one 4½-in. brick lining every eight or nine months. The linings have had lives two to three times as long since the balanced-blast cupola was installed. In regard to the previous statement, a first-quality Sheffield ganister and a good-quality firebrick are used; the latter is of rather a different shape from the type customary in British foundry practice; it is known as side-arch shape, and there are two sizes, 2 in. by 3 in. by 4½ in. by 9 in. and 2½ in. by 3 in. by 4½ in. by 9 in.; they are, of course, set with the length of brick vertical. This method of lining a cupola is very common in the United States, and when the author first tried it, he was rather sceptical, and even now he would not be prepared to say that it is a better way than the one more common in this country; but since using this type of lining and the balanced-blast cupola system he has been much more satisfied with the life of the lining which, considering the very arduous duties it is called on to do every day, is very satisfactory. Finally, a ½-in. layer of ganister is always placed on the new brick lining, from the baseplate to well above the tuyeres, as it gives a good protection to the brickwork during the first melt.

The Weight of Charges

In the works with which the writer is associated, the size of the metal charge has to bear some definite relation to the amount of metal per tap. Actually, the amount tapped is approximately equal to the weight of one metal charge; it was found by doing this along with other control, it was possible to obtain the most uniform composition over the entire melt, and this is most necessary in producing cupola blackheart malleable. If, for example, the silicon varies more than 0.15 per cent. for a given carbon content, difficulty is experienced in obtaining a properly annealed product, or, on the other hand, freedom from primary graphite in the heavier sections in the as-cast conditions. An endeavour is made to standardise and synchronise as far as possible all steps in charging and tapping practice; the well is of size to carry rather more than one metal charge, so that the metal is always covered with a layer of slag, and as soon as slag flows freely the metal is tapped; occasionally the melt is raised so that a little just passes out of the slag hole. This is done in order to make sure that the slag is not building up in too great an amount, and so cutting down the metal capacity of the well.

In all cupola practice, where high temperature and very fluid metal is required, Fletcher found that one must be careful to avoid shallow metal charges, as under such conditions the metal oxidised rapidly when sandwiched between shallow coke charges, so that in practice the weight of the metal charge will vary for the requirements of the individual foundry. Further, in the case of all cupolas, the use of heavier-weight charges, metal or coke, may often result in increased metal temperature and less coke consumption, as it may be possible to reduce the amount of coke per charge gradually. On the other hand, if too great a metal charge is used, then dull metal is apt to arise, because the bed may be burnt too low before the coke charge can replenish that burnt from the bed.

As a guide to arriving at what the weight of metal charge should be, the author would mention that his weights are based on approximately one-eighth of the melting rate, that is, for an output of 4 tons per hr. the metal charge would be half a ton; actually, on our malleable cupola this figure is 1,000 lbs., and when the cupola was operating on 3 tons per hr. the metal charge was 750 lbs.

Coke Charges

In the case of the malleable-cupola practice under consideration, the ratio of coke to metal, excluding the bed, varies from 10.5 to 11.0 – 1, that is, the weight of each coke charge varies from 95 lbs. to 90 lbs. The cokes used are first- and second-quality Welsh cokes, one being rather less strong and higher in sulphur and ash than the other. The first quality is used alone to make up the bed, whilst for the charge coke the two are mixed in equal proportions. The metal mixture contains about 25 per cent. steel.

Limestone

There are tremendous variations in the amount of limestone recommended to be used per charge, but the author is of the opinion that the fairly generous use of a good quality limestone, of about egg size, certainly not larger, is a very distinct asset to good running of the cupola. Limestone additions should start with the bed if you want to get the lowest possible sulphur from the start of the melt. In the practice under review 30 to 50 lbs. of limestone is put on the bed and 25 to 30 lbs. per 100 lbs. of coke charge. The B.C.I.R.A. recommend a weight per cwt. of coke charge of approximately 26 lbs., but this, of course, will vary for different foundries, depending on the pig and scrap.

Air Requirements

It requires approximately 150 cub. ft. of air at normal temperature and pressure to burn 1 lb. of pure carbon to CO_2, but a best-quality coke will only contain, say, 92 per cent. of carbon, so that only this amount of 150 cub. ft., that is, 138, say 140 cub. ft. of air per lb. of coke will be required. Now, considering the coke ratio of 10.5 to 1, one ton of iron requires 213 lbs. of coke, and this time 140 gives us 29,820 cub. ft. of air required per ton of iron. It is usual to allow some excess to cover loss, etc.; 5 per cent. is a safe figure to allow, if it is more than this there is a serious risk of dull and/or oxidised iron. The final figure will thus be 31,311 cub. ft. of air per ton of iron, or approximately 125,000 cub. ft. per hr. It will, no doubt, be of interest to record that if a cupola is to operate continuously, some American authorities consider that the air volume can be cut by 10 per cent. In all practices the author would strongly recommend that a somewhat lower amount of air than calculated be used, that is, to employ nearer the minimum than the maximum, as will be seen later.

In modern cupola practice it is recognised that pressure is only of secondary importance compared to the *volume* of air entering the cupola. It is usual to consider 150 cub. ft. of air per lb. of carbon or approximately 140 cub. ft. for a 92 per cent. carbon coke, but several authorities, as H. V. Crawford,[1] of the General Electric Company, U.S.A., have shown that this amount of air may vary appreciably as atmospheric conditions vary, and this authority goes to great detail to explain that very serious errors can arise if the old figure of 150 cub. ft. per lb. of coke be taken as a basis for the amount of air required, and that the amount of air required at normal temperature compared to that required under minimum conditions of 0 deg., 15.2 c.m. barometer, and no humidity will be from 30,000 to 20,500 cub. ft. per 2,000 lbs. of iron. In view of this, to be strictly correct in modern cupola practice, a constant *weight* of air should be used, not a constant *volume*, in order that the supply of oxygen is constant in amount; after all, one is only concerned with the oxygen content of the air. The American G.E.C. (British Thomson-Houston) has devised a very efficient and fairly simple equipment automatically to control the weight of air entering the cupola, but the author has had no experience of this equipment or control of air by this method, but understands that there are a number of foundries using this equipment in the States and are very satisfied with it. On the other hand,[2] a writer in "The Foundry," October, 1933, puts forward a very cheap and simple method of controlling the *weight* of air entering the cupola; it is, however, not automatic, and only suitable for a cupola having positive pressure blowers; a variable-speed motor is recommended.

Blast Pressure

As is well known, the pressure of the blast usually increases with increase in diameter, and at one time the tendency was to blow at high pressure, and this practice was initiated in the days when positive blowers were more popular than to-day; and, as Hurst[3] points out very clearly in his book, the introduction of fan blowers rather confused the interpretation of the meaning of pressure. The positive blower gives a positive pressure, but in the case of the fan the indicated pressure depends to an extent upon the resistance offered by the charges and obstruction at the tuyeres, and, quoting Hurst, "does not necessarily indicate the effectiveness of air penetration into the charge." For this reason knowledge of volume of air delivered to the cupola per unit time becomes of increasing importance.

The author's practice is to blow with as low a pressure as is consistent with obtaining the required air volume and melting rate, all other things being equal; and when the cupola was at 27-in. bore diameter, the average blast pressure was 7.5 ozs. If the foundry work was light, it was found possible in the case of the balanced-blast cupola to run at as low a pressure as 5 to 6 ozs. and still get very hot iron. For the present lining of 32 in. the average pressure is 10 ozs. In all these cases the pressure was that as measured in the belt.

Thermal Efficiency

It was hoped to present a thermal balance-sheet of the balanced-blast cupola referred to, but the idea had to be abandoned, as there are not yet sufficient data for a correct thermal efficiency to be calculated, and it was felt that to take assumed figures would be of no real value. In fact, on going carefully through many British Papers on cupola practice, the writer was only able to find one example of a cupola thermal balance-sheet, and even this one contained a number of assumed constants. However, the rarity of such information is illustrated by the fact that he found this particular balance-sheet quoted in different forms in no fewer than six technical Papers. In Hurst's book[3] figures are given of thermal efficiencies arrived at by investigators, as Piwowarsky, Meyer and Hejemana, and these vary from 20 to 46.0 per cent.; these figures are largely those of Piwowarsky and Meyer's work. The theoretical efficiency is in the neighbourhood of 50 per cent.

Dr. Marbaker,[4] Director of Research Division of the Whiting Corporation, presented a very interesting Paper to the A.F.A., which contains the calculated thermal efficiencies of a number of 54-in. diameter cupolas, the calculations being made from figures supplied by a number of foundries. The thermal efficiencies were found to vary from approximately 26 to 37 per cent. Figures have been published claiming thermal efficiencies of 55 to 65 per cent. for the Griffin hot-blast cupola system, the highest efficiency being obtained when the blast had a temperature of 600 deg. C. From the above review it would appear that probably average cupola thermal efficiency is in the neighbourhood of 35 per cent., but this figure should be accepted with much reserve. The following briefly indicates the practice in use at Crane, Limited.

1 "Automatic Blast Gate Control for Cupolas." Transactions of the American Foundrymen's Association, vol. 36, page 525; and FOUNDRY TRADE JOURNAL, vol. 40, page 65.

2 "Weigh all Air entering the Cupola," Alexander W. Weston, "The Foundry," October, 1933, page 24.

3 "Melting Iron in the Cupola," J. E. Hurst, pp. 123, 124 and 125.

Tap Hole

A special tapered firebrick is used having the following dimensions: 9 in. square on front and 6 in. square at back, 9½ in. long, and having a hole through its horizontal axis of 3 in., tapering to 2½ in. This brick is cut into two approximately 4¾-in. lengths, and the 9-in. square portion is used for the tap hole; the front face has a radius to fit the cupola shell.

The tap hole proper is made up with ganister around a ⅝-in. tapered wood pattern, giving a hole length of about 4½ in. The diameter of the hole inside the cupola is about 1½ in. dia. It may be of interest to point out here that, where the cupola operates with an open tap hole, after the first tap the sizes of the hole for various outputs should be:—½-in. dia. for 5 tons per hour; ⅝-in. dia. for 10 tons per hour; and ¾-in. dia. for 15 tons per hour. For ordinary cupola practice, the author recommends having a tap-hole diameter large enough to tap as quickly as possible in order to minimise loss of heat, provided it is not too large, with the consequent liability of becoming uncontrollable, especially in the case of mis-bots.

Slag Hole

The other half of the tap brick is used and the hole is made up with ganister to 1½ to 1¾ in. diameter, and extends right from the furnace bore to the outside. In our grey-iron cupola, owing to the thickness of the brick lining, the slag hole is recessed back some inches. The slag holes taper from 1 in. at the furnace bore, the larger diameter being at the shell in order that small pieces of coke can easily blow out of the hole.

Sand Bed

The sand bed is put in through a fettling door situated between the tap and slag holes. Black floor or system sand is first put in to a depth of 3 to 4 in., and this is well tucked and rammed round the edge of the bottom doors; then about half a shovel of broken slag is spread over, followed by half a shovel of core sand, and then the bottom is finished off up to a height of 8 in. The whole must be well rammed and yet not too hard, neither must the sand be too high in bond, or there will be trouble in the sand bottom not dropping easily after dropping the doors. Very great care is necessary in making up the sand bottom of a cupola which is to operate for 11 to 12 hrs.

The Coke Bed

The cupola is the heart of the foundry, and the coke bed is the heart of the cupola so far as its effect upon successful or otherwise cupola practice is concerned. Correct height and properly conditioned coke bed are essentials and are more than half-way to successful practice; ignore their importance and there will be trouble from beginning to the end of melt. The amount of coke for the bed is decided by the height required, not a given weight; it is weighed only for the purpose of recording how much coke is used. Wood is spread over the *whole* area of the bed; this is ignited and then about 1 cwt. of coke added, and this is allowed to burn through, then about 2 cwts. more is added; now these additions may not burn through evenly and the following precaution should be taken: the other additions of 1 to 2 cwts. at a time are not just forked on anyhow, *the coke is put on in the places where previous additions have burnt through*; the additions are continued until all but the last 4 to 6 in. of bed coke has been added, then, when this has burnt through *evenly* and is level, the gauge stick is inserted and coke added to bring the bed to its correct height. In the practice referred to the height of the bed is 54 in. above the bottom of the main tuyeres. Then 50 lbs. of limestone is put on, or can be mixed with last 3 or 4 in. of bed coke, followed by one coke charge plus 25 lbs. of limestone, also mixed in the coke. Charging of the cupola commences immediately and, as soon as finished, blowing commences at pressure and volume previously indicated. The cupola is charged up to platform level, that is, 3 ft. below the charging door sill, and holds seven metal and coke charges. The tap hole is left open until the first metal passes the tuyeres, usually five to 6 min., then it is stopped up with floor sand. For botting up after each tap a good strong clay mixed with a little coal dust is used.

Checking Condition of Bed

Once one has determined a satisfactory height, etc., for the coke bed, it is possible to check the cupola man by the analysis of the first few ladles tapped; in fact, this becomes necessary in making cupola black-heart malleable in order to maintain as uniform a composition as possible; the permissible variations are very small. Briefly, the condition of the bed is indicated by the silicon, sulphur and total carbon contents; for example, if these elements, especially total carbon and sulphur, are appreciably higher than the results obtained when you have known bed conditions, which should be standardised, then it is safe to conclude that either the bed was too high or not burnt through uniformly or to the same extent as the standard requires; on the other hand, low silicon and total carbon and, maybe, sulphur, indicate the reverse bed conditions.

Weighing the Charges and Charging

It need hardly be said in these days that all material comprising the charge should be weighed. All raw material arriving for use in the cupola is loaded into the bins, and the charge, exclusive of coke, is weighed into the buckets seen, which are mounted loosely on bogies which travel along narrow-gauge rails over the weigh scales. The weigh scales used are Avery dial machines weighing up to 1 ton, and the dial is marked off in 4-lb. divisions. These machines are very efficient, simple to operate; in fact, once the scale is set "to weigh," no further attention is needed beyond adjusting the tare weight for the different buckets and bogies.

The buckets are pushed round till they come under the area in the charging platform through which the charging crane hook is lowered. The method we adopt for mechanical charging is also a very efficient one and can now be purchased in this country. Essentially, it comprises a drop-bottom bucket, previously referred to, for carrying the charges; it is used in conjunction with a crane which can hoist or lower, travel forward, as when the bucket is passed into the charging door; also, it can travel to and fro on rails across the cupola platform.

The bottom of the bucket is closed by two flap doors, hinged and locked by a simple arrangement. By pulling the release cable attached to a yoke type lever around the top of the bucket, the latches holding the two half-doors are released and the doors swing down to the centre axis, and so the charge is dropped into the furnace. The doors are closed by lowering the bucket back on to the bogies; sometimes a little pressure on the lever surrounding the bucket is necessary in order to make sure that the latches engage correctly with each half-door. The coke charges are weighed into hand-scoops holding about 50 lbs. This is done from supplies of coke kept on the cupola platform. The writer prefers to put the coke charges on separately in order to keep these coke layers as even as possible and hence keep the bed equally uniform.

Fine Control of Metal Composition

Apart from careful weighing of the pig, steel and scrap, variations in the pig-iron is controlled by varying additions of 45 per cent. ferro-silicon briquettes and 20 per cent. spiegeleisen or manganese briquettes. Briquettes are, undoubtedly, the most economical and efficient means of adjusting, or adding such elements as silicon, manganese, etc. Further, small amounts of 45 per cent. ferro-silicon pieces are added to the mixing ladle.

Sulphur and Carbon Pick-up

These will, of course, vary according to one's practice, to the condition of the bed, fluxing, etc., and it is impossible to give any definite figures as to what one might expect; it can be said, however, that the more rapid the melting the less will be the carbon and sulphur absorption. In the case of the balanced-blast cupola the author found that carbon absorption was appreciably less than that obtained with an ordinary cupola using the same coke, and the same applies to sulphur, only to a greater extent, that is to say, in this case it may be only 50 or 60 per cent. of that obtained from an ordinary cupola.

In both the malleable and grey-iron foundries a standard fluidity test, known as the "Sipp" test, is run regularly. This, when fully run, gives a 60-in. spiral of metal. There are pip marks every 2 in. in order that the fluidity value can be very quickly determined. [The author showed two examples of this test, one obtained from the malleable and one from the grey-iron foundry.]

In conclusion, the writer desires to express his sincere thanks to the directors and to the works superintendent of Crane, Limited, Ipswich, for their permission to publish this Paper.

[4] Transactions of A.F.A., vol. 37, page 71.

Tinned Scrap in the Blast-Furnace Charge

By E. J. Fox (Managing Director of the Stanton Ironworks Company, Limited)

During the past few years a considerable quantity of scrap has been available for use in blast furnaces which is unsuitable for other purposes. The writer refers particularly to compressed tins. In some instances these tins are treated by an electrolytic de-tinning process, and are then compressed into suitable sizes for charging into blast furnaces. There is also available a large quantity of untreated compressed tins, and most of the large towns have now available a compressing plant for bundling these tins together.

There is no doubt that of recent years there has been a tendency for people to eat more tinned foods, and even in this country the canning industry has expanded, and many of our home vegetables, etc., are now canned. The manufacture of tins in itself leaves a certain amount of residue of stampings available for compression and use as scrap in the blast furnaces.

The steel-maker, of course, will not look at scrap which has not been de-tinned, and is even chary of the use of de-tinned scrap, on account of the uncertainty of the scrap being perfectly de-tinned. The price at which this scrap has been available has made it economical for use in pig-iron manufacture. At the same time it would be a pity not to dispose of this scrap by putting it into use, and nothing is more unsightly than waste dumps covered with old tins which were becoming common in many towns.

The effect on the analysis of the pig-iron due to use of this scrap has been usually to reduce the phosphorus content; otherwise, unless used in very large quantities, no noticeable change in analysis would be brought about. Shortly after the war large quantities of steel turnings from various shell shops were available and were largely used in blast furnaces; but this source of supply has long since been exhausted, and the amount of steel turnings available to-day is small.

Cast-iron scrap usually finds its way direct into the cupolas, but a certain amount of this scrap is known as burnt metal and finds its way into blast furnaces. These quantities are, however, so small that they cannot have any material effect on the blast-furnace industry.

Cupola Linings*

By J. C. Green (Gibbons (Dudley), Limited)

I understand that there are about 3,000 active iron foundries in the British Isles, so that at a conservative estimate there must be approximately 5,000 cupolas in action, which means that the potentialities for an improved lining are considerable.

Cupolas are charged from the top with pig-iron, scrap iron and steel, limestone, and coke; in some cases fluorspar is also added as an additional flux. Air is inserted under pressure through tuyeres just above the slag line of the cupolas. In some of the more up-to-date foundries, auxiliary tuyeres are used above the usual row of main tuyeres. In these cases the blast of air is controlled (balanced-blast cupolas).

There are very varied opinions as to what temperatures are attained in cupolas, but there can be little doubt that the minimum temperature in the melting zone, if the coke is efficiently burnt, must be in the neighbourhood of 1,700 deg.

The higher sections of a cupola are not subject to high temperature conditions, but must be resistant to abrasion, caused through the scraping action of the descending charge, and at the top, actual impact of the material charged.

It would appear, then, that the higher sections of a cupola require a hard, well-vitrified, dense lining, not necessarily of high refractoriness, whereas the melting zone requires lining with material well above the average in refractoriness, and should be capable of supporting the lining above it without seriously lowering its refractory properties.

The general practice at the present time seems to be to line cupolas throughout with the cheapest firebricks obtainable, and complacently to spend an enormous amount of money in providing an inadequate patching material, siliceous in composition, to repair the daily ravages on the lining in the melting zone.

Dr. Skerl, in a Paper read before the East Midland Branch of the Institute of British Foundrymen in 1932, stated "that some of the earliest cupolas around Sheffield were lined with lumps of local rock, rough-hewn at the quarry; these were highly siliceous in character, and were eventually replaced by firebricks probably because firebricks could be produced cheaper to give the shape of the cupola."

Certain of the larger foundries to-day are using a more expensive brick, higher in alumina than ordinary firebricks, for their general lining, but still use ganister or similar material for repairing the damages in the melting zone.

The only alternative to a brick lining used in the country to-day is the rammed lining, using plastic refractory material, which, although it should theoretically possess many advantages over the brick lining with innumerable joints, has not been very widely adopted. I understand there are probably not more than 10 per cent. of the cupolas in the British Isles containing rammed linings.

The material used for ramming is siliceous in character, and the refractoriness is seldom, if ever, higher than 1,670 deg. The ravages in the melting zones of rammed cupolas are treated with siliceous patching material in much the same way as the brick-lined cupola.

It is evident, then, that whether the cupola be lined with brick or rammed, the lining in and near the melting zone is at present the costly part to maintain. The amount of material used for periodical or daily patching varies enormously, and only in certain cases bears a definite relationship to the tonnage of metal cast. Variations to the order of 25 per cent. are known, and have been published.

The working conditions in cupolas in different foundries naturally vary considerably. For this reason it is very difficult to make definite statements and say that the lining cost should be so much, and no more, per ton of metal cast; also, the human element, that ever-variable factor, plays such an important part in the operation of daily patching that standardisation is almost impossible.

A metallurgical correspondent to THE FOUNDRY TRADE JOURNAL, in August of 1932, wrote that "the items of cost in cupola-melting practice are often the subject of much discussion. In spite of the enormous accumulated experience of cupola melting which must exist amongst foundrymen, it is often surprising to find gross ignorance displayed on the subject of the prime items of cost in this melting process. This is probably true, more of ganister, or patching material, than coke costs."

Cupola control has undoubtedly a very distinct bearing on lining life, and more precisely slag control; the constituents of the slag, in addition to the lime, are obtained from the silica or the pig-iron, the ash in the coke, impurities accidentally charged with the scrap, and the siliceous material used for repairing the melting zone. It seems, then, that if an excess of limestone is added, as it probably is in many cases with the idea of aiding desulphurisation, the lining is attacked by this excess of flux. Excess of limestone is probably one of the most common causes of the rapid destruction of the lining in the melting zone.

I have been unable to discover that any large-scale experiments have been carried out with material other than siliceous for patching purposes. This is rather surprising when one considers that most experts agree that the most satisfactory lining brick is of the aluminous class containing only a small quantity, if any, of free silica.

It appears that plastic material of similar chemical composition to the lining bricks should be more satisfactory than the usual siliceous material. This is not an original idea. Mr. Presswood put it forward in a Paper before the Institute of British Foundrymen a year or so ago; but the proverbial conservatisms of the Englishman and his penchant for muddling through in the same old groove may explain the general apathy with which the idea has been treated.

Rammed Linings

The general reluctance to adopt rammed linings may be due in a measure to the same cause, although probably the main reason why rammed linings have not been more generally adopted is to be discovered in the facts that to apply this type of lining successfully is more difficult than bricking and there are more snags to be overcome.

The size and output of the cupola also have a bearing on the matter. With present practice it is generally acknowledged that for a cupola melting small quantities, the brick lining with the daily patching is the more economical. The properties necessary in a rammed plastic lining are high refractoriness, mechanical strength, resistance to abrasion and resistance to the action of fluxes.

The material for ramming must contain the minimum of water to allow of easy ramming, to compress compactly and evenly, so that the finished lining is uniform. The grading of the grog particles should be such as to ensure a limited area of attack for chemical influences.

Peeling and scurfing will take place during the drying operation if there is too much water in the plastic material and if the grading of the grog is not satisfactory. The material should possess a long vitrification range, and the surface should sinter slightly. This enables the charge to work down the cupola easily and prevents powdering. The rammed lining should be approximately 10 in. thick.

Before beginning the operation of ramming, it is necessary to clean out the old lining and to work on a perfectly even surface. Drying must be carried out slowly and carefully; the heat should be applied as uniformly as possible and must reach all parts of the lining. After drying, the lining should be examined for cracks and holes, and these should be carefully made up before applying sufficient heat to sinter.

To produce a one-piece lining satisfactorily is a difficult operation requiring patience and skill. By proper treatment and careful application it has been proved possible to produce a very satisfactory lining of this type.

The Cement Gun

The cement gun manufactured by the Cement Gun Company, Great Britain, Limited, offers possibilities for placing a one-piece lining and eliminating some of the snags encountered when the ramming method is used. The cement-gun method would be to shoot the dry materials—grog and clay, with the exact amount of water necessary to give adequate binding—at high pressure from the nozzle of a cement gun upon the walls of the cupola. The amount of water added can be regulated, by an experienced operator, to a nicety.

When the mixture is placed, only the finest materials remain, at first, upon the surface shot against; as soon as a matrix of fine material is built up of sufficient thickness to hold the larger particles, the materials placed begin to hold particles of all sizes. The "rebound," that is, material rejected, performs a valuable function in that it is the means of driving the matrix into each crevice, depression, or pore of the surface shot against.

Owing to the increased density of the materials placed by this method, over the same materials placed by hand, and the fact that minimum hydration can be attained, cracking during setting and drying would be eliminated, and therefore greatly increased resistance to attack should be secured.

The material dries very quickly, and sets well through being applied at a high pressure (three to four atmospheres). As a rough guide as to how long it would take to line a cupola, an experienced nozzle-man and operator would place 25 to 30 square yards, 2 in. thick, during an eight-hour shift. It is possible that a cement gun in a foundry might be a very useful tool for applying the daily patch.

At a recent meeting of the London Branch of the Institute of British Foundrymen a discussion took place on cupola linings, and M. Deschamps, of Messrs. Kryn & Lahy, moved a resolution that the Furnaces Committee of the Institute prepare a questionnaire regarding linings to be sent round to all foundries. By this means it should be possible to collect valuable data, and eventually to clear up some of the obscurity with which the general position is clouded.

The one thing that is palpably clear at the moment is that to produce an adequate and satisfactory lining for the melting zone of cupolas is no easy matter. The conditions are very severe, and very necessary properties obtained to a high degree in one direction will prevent the development of other necessary properties in another. So that a happy medium will have to be found. In the search for a better lining, the foundryman can give material assistance by experimenting, studying, and tabulating the variable conditions in his cupola. This, with whole-hearted co-operation with the manufacturers of linings, will go a long way towards solving the problem.

* Paper read before the Autumn Meeting of the Refractory Materials Section of the Ceramic Society.

The Works of the Sheepbridge Coal & Iron Company, Limited

By P. A. Fox-Allin

The Sheepbridge Coal & Iron Company, Limited, is amongst the few concerns in this country who are still extensively engaged upon the productions for which the works were originally laid down, namely the manufacture of pig-iron and the rolling of wrought-iron bars and sections. During the succeeding years many changes have been made in plant and method to maintain the works well in line with the most modern practice. Steel bars and sections are now rolled; the staple production of the mills, however, remains good-quality iron; cheaper grades are not, and indeed never have been, rolled at Sheepbridge.

It is in the section devoted to general engineering that there has been the most appreciable extension in the company's activities. For the most part, these activities might well be said to be the natural development of a company with large colliery interests. The engineering shops were originally laid down to do no more than meet their own requirements for maintenance and the supply of their own collieries. It was perhaps only to be expected that a company who were users as well as builders of colliery machinery would introduce modifications in design and construction which would appeal to the mining community in general. There was an almost immediate demand for the supply of their specialities, and considerable extensions had to be made alike to foundry and engineering shops to meet these demands; so that at the present time colliery and general engineering forms a very important branch of the company's activities.

In 1864 the Sheepbridge Company purchased the properties of the Dunston & Barlow Company, comprising four blast furnaces, a small foundry, mechanics' shops, ironstone pits, and a small colliery.

Blast-Furnace Plant

The four furnaces taken over were, of course, of small capacity, and to meet the increased demand for iron a further four furnaces were built. These were dismantled at a later date and their duties taken over by four furnaces of larger capacity, which had an ultimate output of 500 to 600 tons per furnace. It may here be noted that the Sheepbridge Company was probably the first in this country to generate electricity by gas engines utilising blast-furnace gas.

When the last-erected furnaces had reached the limits of their useful life, it was determined, rather than attempt to re-design them, to build two furnaces, the combined output of which should be equal to the four old furnaces. After exhaustive investigation of plants in this country, on the Continent and America, it was decided to adopt, what was then known as the American type, and the furnace built at Sheepbridge in 1902 was amongst the first, if not actually the first, of the type to be built in this country. The furnace is of the double-bell mechanically-charged type, 70 ft. high. The bosh is 18 ft. dia., the hearth 13 ft. dia., and is supported on ten cast-iron columns. The stock line is protected by mild-steel strips, 6 in. by 5 in. There are nine tuyeres for blowing and one for slag; the tuyeres are fed from a heavy cast-steel belt. The bosh and hearth are cased in and water-cooled.

The No. 4 furnace, built in 1923, is of the same type and height, with a bosh 19 ft. dia. and a hearth 13 ft. dia. This furnace is supported on five built-up steel columns. There are ten tuyeres for blowing and one for slag, all supplied from a cast-steel belt. The tapping hole is gun-operated by compressed air at 100 lbs. per sq. in.

The two furnaces can be blown together if necessary, but for the time being the No. 5 furnace is standing ready. The No. 4 furnace has now been in blast for seven years, and is still doing excellent work.

Charging Arrangements

Both furnaces are automatically charged by double inclines with tilting skips, which receive their load from electric trolley-cars travelling the line of bunkers and kilns. It may be noted that the bunkers for the No. 4 furnace are entirely in ferro-concrete, whilst those for the No. 5 furnace are timber, mild-steel plated. In both cases the hoist engines are of the steam-driven type. Both furnaces are fitted with gear for controlling the distribution of the charge and with automatic-signalling devices showing the position of charges on the bell and the opening and closing of the bells.

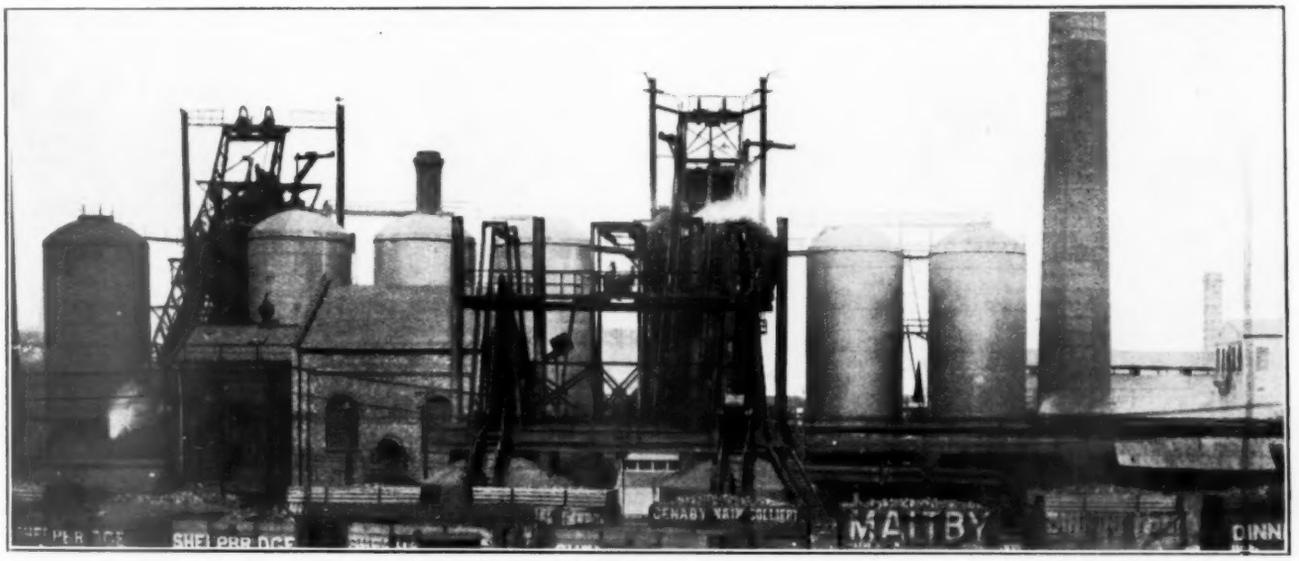


FIG. 1.—VIEW OF NOS. 4 AND 5 BLAST FURNACES AT THE WORKS OF THE SHEEPBRIDGE COAL & IRON COMPANY, LIMITED. CALCINING KILNS ON RIGHT.

TABLE I.—*Analyses of Sheepbridge Pig-Irons.*

Grade.	Graphitic carbon. Per cent.	Combined carbon. Per cent.	Silicon. Per cent.	Phosphorus. Per cent.	Manganese. Per cent.	Sulphur. Per cent.
"SHEEPBRIDGE" FOUNDRY IRON						
Silky	3.50	0.05	4.0–5.0			0.01–0.02
No. 1	3.70	0.08	2.5–4.0			0.01
No. 2	3.50	0.12	2.5–4.0	1.4–1.5	0.8–1.4	0.02
No. 3	3.25	0.24	2.0–4.0	Average 1.45	Average 1.20	0.03
No. 4 Foundry	3.10	0.30	2.0–3.5			0.04–0.06
No. 4 Forge ..	2.80	0.50	2.0–3.0			0.06–0.08
			All stocked in 0.5 per cent. ranges.			
"SHEEPBRIDGE" BASIC IRON						
No. 5	2.50	0.50	0.9–1.2			0.05–0.07
Mottled ..	1.60	1.40	0.8–1.0	1.4–1.6	1.3–1.7	0.06–0.09
White ..	1.00	2.00	0.6–0.9	Average 1.50	Average 1.50	0.08–0.10
"NEWBOLD" MEDIUM PHOSPHORUS FOUNDRY IRON						
No. 3	3.40	0.20	2.5–3.5	0.65–0.75	1.2–1.6	0.025–0.035
No. 4	3.20	0.30	2.5–3.0	Average 0.70	Average 1.30	0.04–0.06

Each furnace is served by two kilns, which are mechanically charged with incline and tilting skips, electrically driven. Each kiln is capable of efficiently calcining up to 700 tons per week when dealing with Frodingham rough limey stone. There are ten stoves of the Cowper type, each 70 ft. high by 22 ft. dia. Of these, four are in use per furnace and one off for cleaning. The stoves are heated with unhaust into two large evaporating condensers giving a vacuum of 23 in.; these will, however, shortly be displaced by modern condensers to give a vacuum of 27 in.

Steam is raised in ten Lancashire boilers each 30 ft. by 8 ft. 6 in. and four Babcock & Wilcox boilers each of an evaporative capacity of 800 galls. per hr. All the boilers are gas-fired; they are furnished with combustion chambers

Slag is run directly into Dewhurst slag ladles, of which there are eight 10-ton and 42 of 5 tons capacity. The slag is allowed to cool in the ladles before tipping, and is afterwards broken down in stone breakers for road material, and tar Macadam.

Power Plant

The whole of the electric power used in the works is produced by blast-furnace gas-engine-

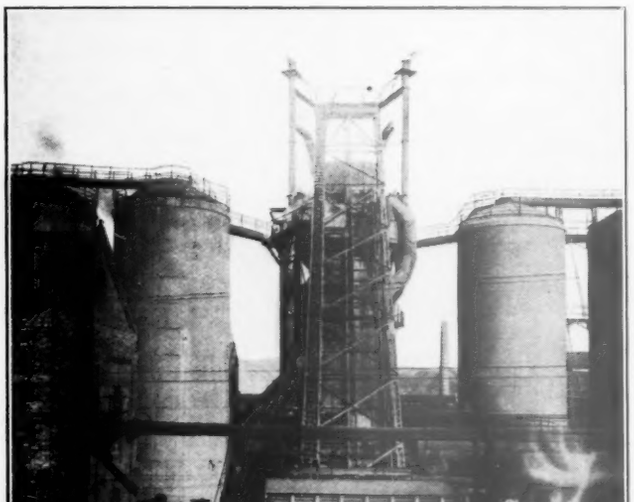


FIG. 2.—VIEW OF NO. 4 BLAST FURNACE.

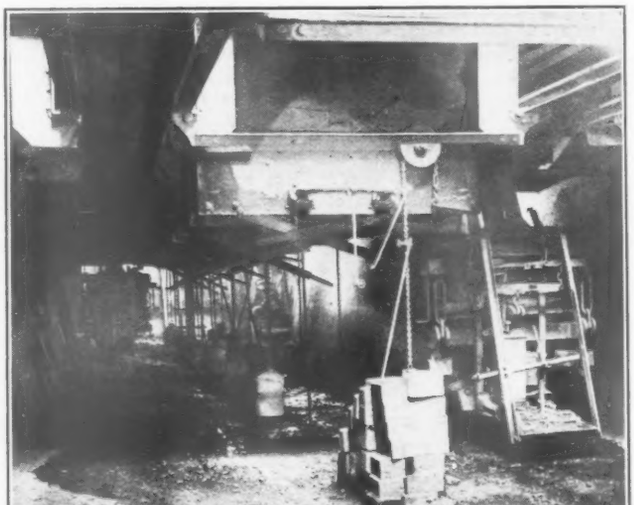


FIG. 3.—UNDERGROUND CHAMPING, NO. 4 FURNACE.

cleaned gas, the temperature of the blast being 1,350 to 1,400 deg. Fah.

Blowing Engines

The blowing engine for the No. 4 furnace, built by Galloways, Limited, has a 42-in. steam cylinder, 100-in. blowing cylinder and a stroke of 60 in. This engine has a capacity of 22,000 cub. ft. of free air per min. when running at 40 r.p.m. The blowing engine for the No. 5 furnace, originally built by the Tees Side

and have automatically-controlled Weyman-type burners. Electric CO_2 recorders by the Cambridge Scientific Instrument Company, Limited, are installed on each boiler and a CO_2 recorder for the main flue. The fuel used is South Yorkshire coke chiefly, and a considerable proportion from Dinnington Main Colliery in which the Sheepbridge Company have a large interest. Limestone is obtained from the Matlock district, while the ores (Lias and Oolite) are from

driven generators. There is at present in operation a National gas engine of 1,500 h.p. direct-coupled to a 1,000-kw. B.T.-H. generator running at 200 r.p.m. and generating at 230 volts direct current. A second similar set is being installed to deal with the increasing demand for power in the works. There are also three Westinghouse gas-engine-driven sets each of 350 kw., which normally act as standby and serve for the week-end load. Gas for the engines is cleaned down to

FIG. 4.—ONE OF THE SHINGLING HAMMERS.

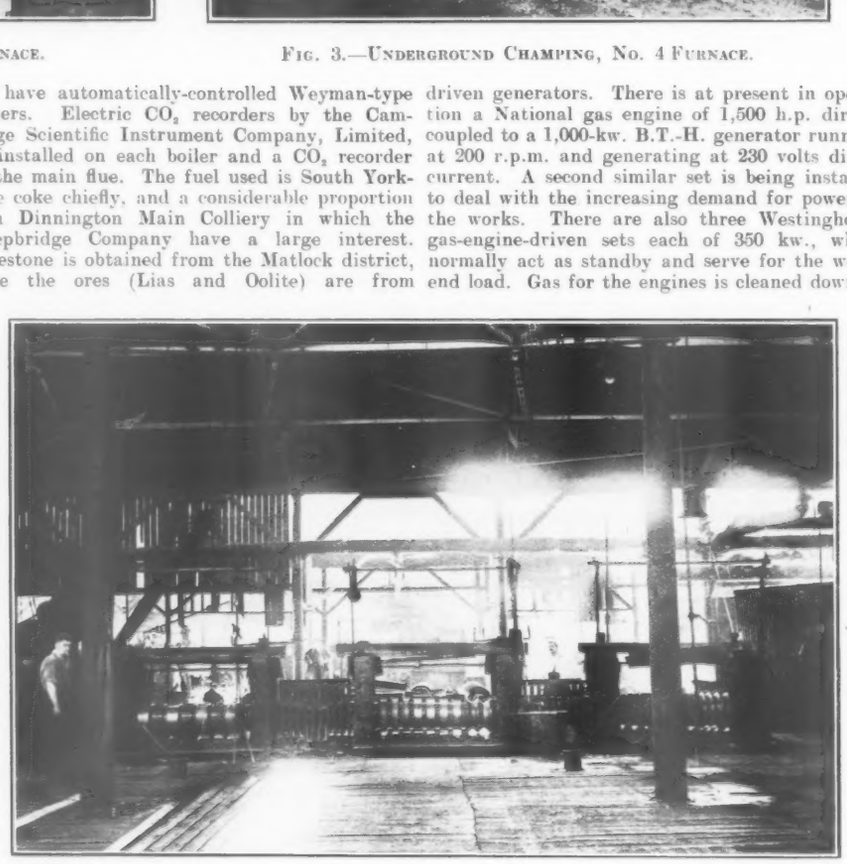


FIG. 5.—VIEW OF FORGE ROLLS.

Engine Company, Limited, rebuilt and remodelled by Richardsons Westgarth & Company, Limited, in 1915, has a steam cylinder, 48 in. dia., blowing cylinder 100 in. dia. and 54-in. stroke, with a capacity at 44 r.p.m. of 21,500 cub. ft. of free air per min.

At the present time the blowing engines ex-

Frodingham (Lincolnshire), Cottesmore (Rutlandshire) and Desborough (Northamptonshire), this last being the company's own mine. Each furnace is capable of producing 1,000 to 1,200 tons of pig-iron per week, according to the type of iron made. Table I gives the analyses of the standard grades.

0.01 grain per cub. m. in water-spray towers. Four coke-fired gas producers are installed for service in case of failure of the supply of furnace gas.

The general hydraulic supply for the works is produced by electrically-driven pumps at a pressure of 700 lbs. per sq. in.

Forge Department and Rolling Mills

This department was originally laid down in 1873; it has, of course, since been reconstructed and considerably extended, and is to-day thoroughly representative of modern practice for the manufacture of puddled iron and the rolling of same into all commercial types of sections—

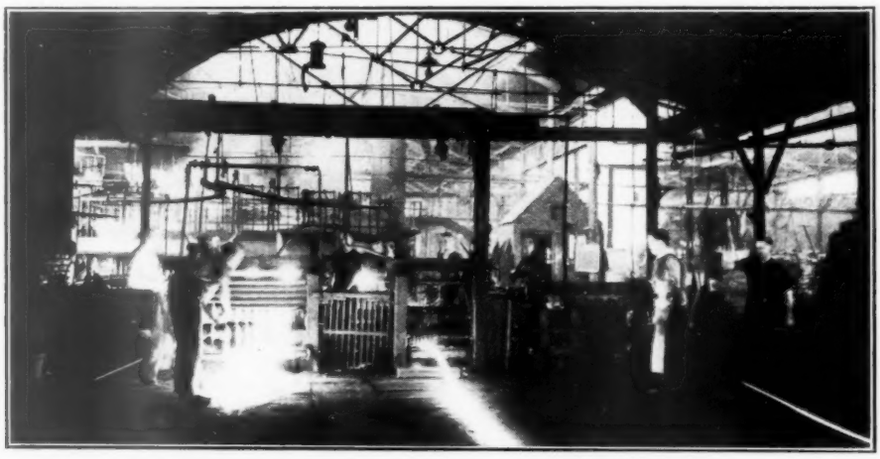


FIG. 6.—VIEW OF 10-IN. GUIDE MILL.

rounds from $\frac{5}{16}$ in. to 6 in., squares from $\frac{5}{16}$ in. to 4 in., flats from $\frac{3}{4}$ in. to 8 in., sections and angles from $\frac{3}{4}$ in. by $\frac{3}{4}$ in. to 6 in. by $2\frac{1}{2}$ in., tees $\frac{3}{4}$ in. by 1 in. up to 6 in. by 3 in. Many of these sections are also now rolled in steel.

Rolling mills comprise a 20-in. reversing mill, a 12-in. and a 10-in. guide mill, and a forge train of three stands of 20-in. rolls, the whole of the mills being steam driven. The forge plant comprises three shingling hammers, two ball furnaces for working up scrap, and fourteen puddling furnaces. The furnaces are of the Siemens regenerative gas-fired type. In a separate building is a 20-ton open-hearth steel furnace, casting pits being arranged for bottom-pouring the ingots. In the test house there is a 50-ton Buckton machine.

ENGINEERING WORKS

The engineering works comprise pattern shop, foundries, machine, fitting, erecting, repair, tub shops and demonstration rooms. The pattern shop is a modern roomy building,

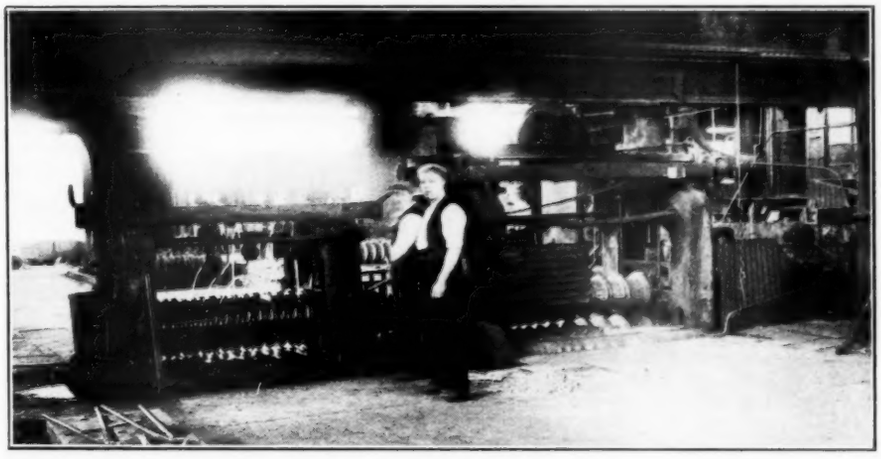


FIG. 7.—VIEW OF 20-IN. BAR MILL.

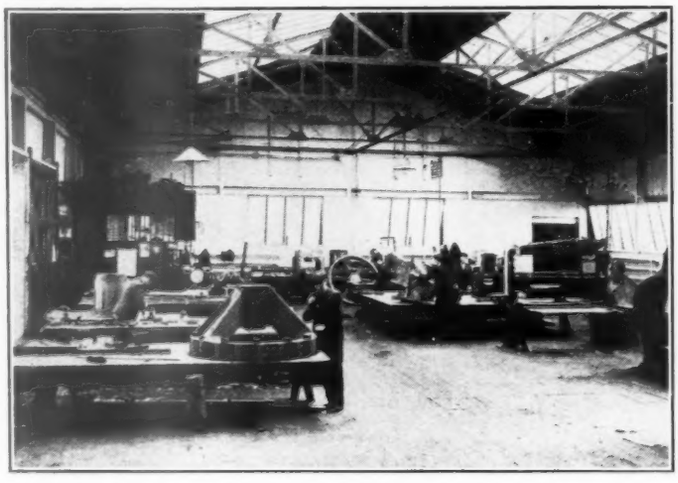


FIG. 8.—PORTION OF PATTERN SHOP.

FIG. 9.—VIEW OF FOUNDRY.

a notable feature being the side lights, which are set at an angle to the wall, the effect being a singularly uniform lighting throughout the shop. The equipment includes all types of modern pattern-shop machines, Watkin woodworkers, planing and thicknessing machine, band sanding machines, emery and sand grinders, lathes, saws, automatic saw sharpener, etc. All waste is delivered by way of a below-floor conduit to the boiler which heats the radiators, etc. From the pattern shop there is a covered way to the pattern stores, which occupies a two-storey building. One floor of this building is laid off entirely for the storage of patterns in connection with the Kennedy products, of which the Sheepbridge Company have the sole manufacturing and sales rights for Great Britain.

Main Foundry

The main foundry, 500 ft. long by 75 ft. wide, is covered by two bays, the main bay being served by three overhead cranes of 50 tons, 15 tons and 10 tons capacity respectively. The smaller bay is served by three 7-ton overhead cranes, and in addition there are two 5-ton walking cranes along the wall side. Of the machines installed, mention may be made of a Tabor shockless jarring machine, which is capable of lifting 10 tons. This machine was built by the company. A sandslinger is also installed alongside this machine and attached to the sandslinger is a revolving turntable upon which boxes having a larger area than the radius of the arm are placed. There is also a range of smaller machines.

The melting plant comprises two cupolas of 10 tons capacity, one cupola of 3 tons and two cupolas of 5 tons melting capacity, the last two being provided with automatic-charging apparatus. The cupolas are fan-blown in pairs, there being also a standby fan for each pair. A receiver is provided of 35 tons capacity for service when heavy castings are being made. Each pair of cupolas are served with a hydraulic elevator, the pig-iron, coke and other material being discharged adjacent to the elevator direct from the wagons, which travel on a high-level track. There are five August drying stoves, the largest being 24 ft. by 30 ft. by 10 ft. Each stove is furnished with ball-race carriages.

Sand is discharged from the sidings into bunkers which feed direct into one of the three pan mills and sand blender, from whence the

sand is delivered into pans of various sizes, thus simplifying the delivery of the amount known to be used on the various portions of the foundry floor. After the moulds are knocked out, the sand is handled by grab and returned to the sand plant for reconditioning. Casting pits are provided in the foundry floor. The capacity of these pits will be appreciated when it is stated that hydraulic cylinders are cast up to 30 ft. in length by 30 in. dia., whilst condenser and bedplate castings are made up to weights of 50 tons.

The whole of the castings for the Kennedy products are made in this foundry. At the time of our representative's visit there were castings being made for the Kennedy-Van Saun gyratory crushers and the coal-pulverising plants, together with a large number of haulage-engine parts (see Fig. 11).

An outstanding speciality is the production of large pipes for super-power stations and the like. One of these pipes is of special interest and, as illustrated (see Fig. 12), its diameter was large enough to permit the passage of an Austin Seven. This pipe formed one of a number of pipes used in the Battersea power-station contract.

The No. 2 Foundry is housed in an annexe to the main building; it is 125 ft. long by 45 ft. wide and is served by two 7-ton overhead cranes. The equipment includes various types of machines. This foundry is devoted entirely to the production of the lighter castings. Car tops and wheels as used in brick kilns, castings for "Wenco" iron roads, and various parts for machines and conveyors, were passing through when visited.

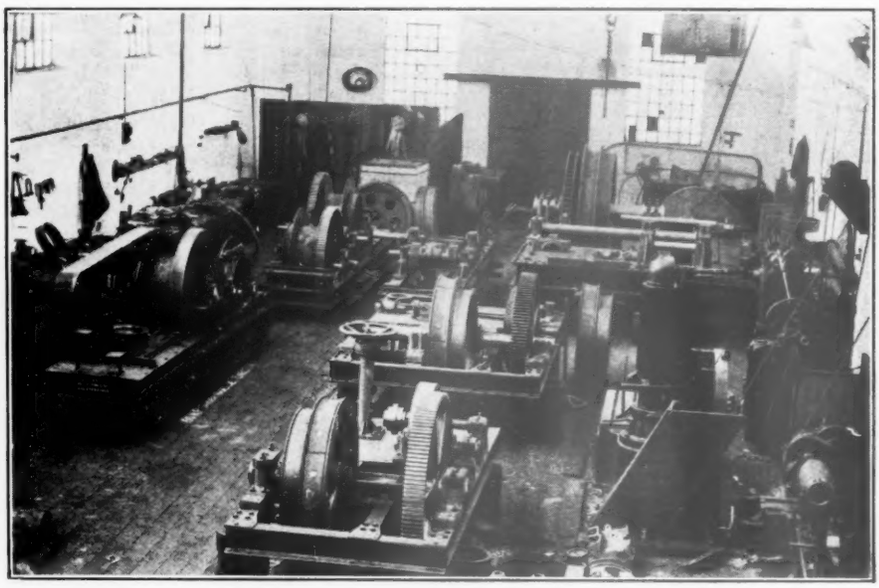


FIG. 10.—VIEW IN HAULAGE ERECTING SHOP.

The core-shop equipment includes the usual mixer for oil-sand cores and a gas-fired stove. It may be noted that four classes of sand are employed in this shop.

The fettling shop is 250 ft. by 75 ft. and the floor is served by a 30-ton overhead crane. A line of standard track extends for the full length of the shop, and this connects up with a double line of track which serves the foundry. The equipment includes a sand-blast plant, complete installation of pneumatic hammers, double-head and portable swing-type grinders, etc.

Main Machine and Erecting Shops

The main machine shop is 268 ft. long by 48 ft. wide, with an annexe 100 ft. by 25 ft. The floor is served by a 10-ton and two 5-ton cranes. Amongst the machine tools installed, mention may be made of a large Stirk planing machine, a 36-in. Parkinson Universal Miller, Kearns No. 5 Universal boring and facing machine, three similar machines of smaller sizes, Herbert automatics and semi-automatics and a battery of Asquith radial drills. This shop was fully employed on steelworks requirements such as rolling-mill gear, stone-crushing machinery, coal crushers, jaw crushers, parts for conveyors, elevators and screens.

The erecting shop is served by one 10-ton and two 5-ton cranes. In course of erection were seen a Kennedy air-swept tube mill and necessary auxiliaries for the pulverisation of fuel, stone-crushing plants and concrete block-making machines; these last the company are building under the Enticknap & Walker patents. There were five large haulages ranging from 50 to 150 h.p. being built to the special designs of customers going through the shop.

One sees many new features in the smaller haulages, in which the company have specialised to a great extent. For example, in the compressed-air haulages, the square valve has been displaced by a circular valve with renewable valve seats. These valve seats are made of special alloy iron to stand continuous wear, and the port holes are milled out to size. This gives an excellent reading on the indicator diagrams taken on these haulages. In the electric haulages of 50 h.p. and downwards, mention may be made of the "Daco" patents, which were taken over from David Ashton & Company, Limited, and the new interchangeable totally-enclosed gear-driven haulages with special inbuilt motor.

A department is also set off for the manufacture of the Carlton patent pipe joint and pipe extension. This latter not only gives flexibility, but extension to the main when the pipes are altered from a straight line.

Fitting and Auxiliary Shops

The fitting shop is laid out essentially as a maintenance shop with machines designed to cover the general requirements of the works and for the expeditious repair of colliery plant. A portion of the shop has, however, been recently set off for the manufacture of a new design of steel pit tub, which is finding a ready market.

Auxiliary shops include the smiths' shop engaged upon general pit-maintenance work, building of pit cages and pressed work such as buffer shields, corner plates, tub bottoms, etc. In the boiler shop, in addition to carrying on the general work of upkeep, pit headgears and gantries are fabricated, mild-steel riveted-type sleepers are fashioned and the steel pressings for the pit tubs are made. In the welding shop are fabricated a special type of explosion-proof container for electrical-control gear for use in mines, and light-weight mild-steel rope rollers. In this shop there is also carried out the general work for the collieries.

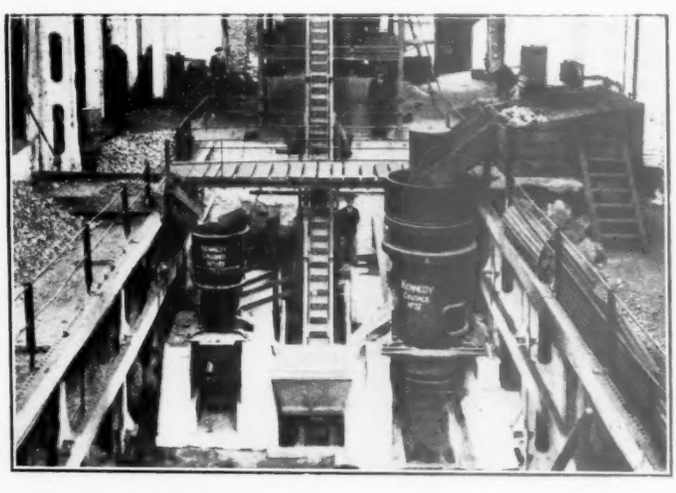


FIG. 11.—KENNEDY CRUSHERS IN DEMONSTRATION DEPT.

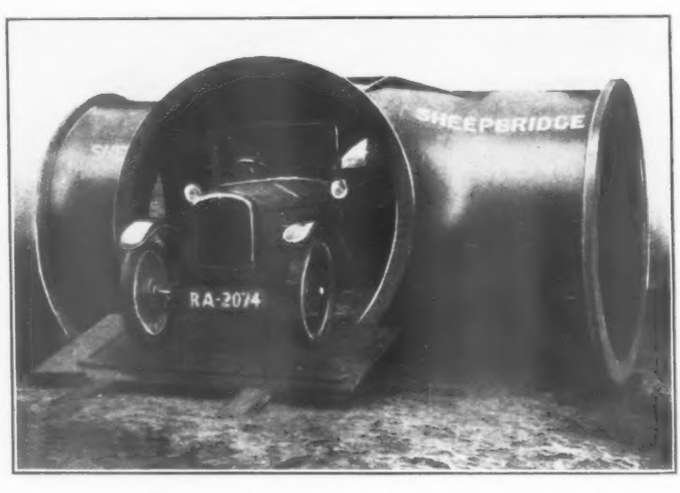


FIG. 12.—CROSS PIPE FOR BATTERSEA POWER STATION.

Foundry Bronzes.—No. I

GUN-METALS

By "Compounder"

The true bronzes or binary alloys of copper and tin are not in general use in the foundry; bell-metal (80 copper : 20 tin) and one or two other special alloys, such as ordnance-bronze (90 copper : 10 tin), forming the exceptions.

Of the gun-metals, the Admiralty alloy (88 copper : 10 tin : 2 zinc) is, unquestionably, the most widely known. Modifications of this mixing in which the percentage of zinc is increased, usually at the expense of the tin, both with or without the addition of lead, serve to provide the non-ferrous founder with a wide range of alloys coming within the category of the "gun-metals." Table I gives the composition of some typical alloys of the gun-metal type in every-day use.

Table I.—*Composition of Typical Gun-metal-type Alloys.*

	Copper. Per cent.	Tin. Per cent.	Zinc. Per cent.	Lead. Per cent.
Pressure bronze ..	Remainder	12–13	1–2	—
Admiralty gun-metal	88	10	2	—
Strong metal for general castings ..	84	8	6	2
Cheap, good-casting alloy	85	5	5	5

Melting-Shop Practice

In compounding any of the alloys shown above or alloys of similar composition, it is advisable, whenever maxima tests are required, to use B.S. ingot copper; otherwise, clean "heavy" copper may be used. Bring the melting container to a good red heat before charging the copper; place a small quantity of well-dried charcoal at the bottom, and melt the copper with as little exposure to oxidising influences as practicable. When melting in crucibles, avoid as far as possible the old-time method of charging, wherein at least a third of the charge projects above the top of the crucible. A section of an old pot may, if necessary, be placed on the top of the crucible so as to form an extension.

Having melted the copper, add the requisite quantity of zinc, in one or more portions at a time according to the weight to be added, and stir gently; then, *after a short interval*, add the lead—if this metal is to be included—and again stir; finally, add the tin, a portion at a time, and stir thoroughly, but not too vigorously. No advantage is gained by unduly superheating the copper when compounding gun-metal alloys, nor is the practice, sometimes adopted, of overheating the complete melt well above the temperature necessary for casting and waiting for the metal to "cool off," one to be recommended.

Foundry Practice

Success in casting gun-metal alloys, particularly pressure bronze and Admiralty gun-metal, demands a knowledge of the idiosyncrasies of the several alloys, also skill and close attention to the details of the best foundry technique; otherwise, low tests and porous castings will result.

Free-venting moulds, rammed-up with an open sand worked on the dry side, and lightly dusted; the judicious placing of scum-gates; the provision of correctly dimensioned and placed risers, runners and intakes; and the adoption of a mode of teeming whereby a firm, continuous stream of carefully skimmed metal enters the mould—are indicative of the points to be studied to ensure the satisfactory and economic production of high-quality castings.

Avoid a long stream of metal whenever pouring molten metal from one vessel to another. Keep the stream as short as possible; *aerated, frothy metal will never make sound castings.* The use of a pyrometer to control casting temperatures is now considered imperative. A casting temperature of 1,150-1,200 deg. C. is normal for gun-metal castings of medium thickness. Scrap metal, other than heads and runners of the same "mix," should not be used unless the proposed charge is compounded by a method of "mixture by analysis." Charges comprised wholly, or nearly so, of a mixture of metal-shop ashes and foundry-skimmings ingots, fettling-shop sweepings, emery-wheel dust metal, and machine-shop swarf, cannot be expected to produce satisfactory high-duty castings, although, maybe, furnishing presentable-looking shapes.

The present-day standard Admiralty gunmetal, although still commonly referred to as 88 : 10 : 2, is acceptable with a purposeful addition of lead up to, but not exceeding, half of 1 per cent. The additional metal replaces a corresponding portion of copper. No lowering of the specification breaking stress of 16 tons per sq. in. is occasioned by this concession.

Do not hesitate, whenever practicable, to scrap a casting for examination for possible defects before proceeding to execute large orders for repetition work. Fracture bars, cast under standardised conditions, afford very good indication of the physical and mechanical qualities to be expected of a gunmetal. Multi-coloured patches on the fractured surface of a bar do not indicate, as is often erroneously assumed, either an imperfectly mixed alloy or a badly oxidised metal. Examination under a hand lens will reveal what is possibly the true state of affairs, namely, that a homogeneous completely-formed crystal structure is wanting, owing to the metal being "starved" through lack of a sufficiency of liquid metal to follow up the contraction of the alloy during the transition stage from the liquid to the solid. It is generally conceded that the inclusion of oxide in a bronze is, for many purposes, most undesirable. The presence of such oxide inclusions in alloys of the gun-metal class indicates careless melting or foundry practice. A charge compounded and melted in accordance with the directions given above, carefully skimmed and teemed without delay, will not carry any appreciable amount of included oxide, and if the casting temperature is correct, the reason for any defect in the subsequent casting must be sought for elsewhere. Ill-conditioned sand is not an uncommon cause of "wasters," notwithstanding that a certain measure of up-to-date sand-conditioning control can be maintained by any intelligent and efficient foundry foreman.

Mr. D. Sturrock's Retirement

Two interesting presentations took place recently in London on the occasion of Mr. D. Sturrock's retirement from the position of managing director of the Sinclair Iron Company, Limited, of Ketley, near Wellington. The first was a dinner and presentation organised by the directors of the Sinclair Iron Company, at which Mr. G. J. Browne (chairman of the directors) presided. In addition to the guest of the evening, there were also present Mr. J. Harding Brown, Mr. H. Lleyellyn Watkins, Mr. W. H. Watkins (who, in 1907, commenced as a junior clerk at Sinclair Iron Works and who has returned, after considerable experience in London and other important centres, to succeed Mr. Sturrock as managing director), Mr. J. H. Jones, Mr. W. G. Hearn (secretary of the company), Mr. J. L. Sturrock, and Mr. Picken (works manager). During the interval in the programme Mr. G. J. Brown presented Mr. Sturrock with a gold watch, and Mrs. Sturrock with a silver, gilt and enamelled toilet service in case. There was also a further presentation to Mr. Sturrock of a tea service of old silver.

Mr. Sturrock was also the guest of Allied Ironfounders, Limited, at the Hotel Metropole, London. A large and representative gathering assembled, and Mr. A. W. Steven, chairman of the directors of Allied Ironfounders, who was accompanied by other directors, presented Mr. Sturrock with a clock and candlesticks to match.

New Etching Reagent for the Phosphide Eutectic in Cast Iron

In order to make visible the different constituents of the ternary phosphide eutectic, W. Heike and J. Gerlach* have developed a new etching reagent consisting of the following four solutions:—(1) 2 per cent. alcoholic nitric acid solution; (2) 100 c.c. of distilled water, 100 c.c. of alcohol, 10 c.c. of concentrated hydrochloric acid, 10 grams of tartaric acid, 10 grams of alum, 10 grams of ferric chloride, 2 grams of ferric sulphate; (3) 10 per cent. caustic potash solution, and (4) 10 per cent. caustic potash solution saturated cold with potassium permanganate.

The solutions are applied as follows. The polished specimen is slightly etched in solution 1, rinsed in distilled water and dried; then shortly polish etched with solution 2. Without being rinsed the specimen is then placed in solution 3 and then in solution 4, where it remains for about 1 min. Finally the specimen is rapidly dipped in solution 3, rinsed in distilled water and dried. If this treatment has not been sufficient to produce the correct colouring, the operation is repeated, but without using solutions 1 and 2. In the correctly etched specimen the phosphide shows a light- to dark-brown colour, the iron-rich phase appears darker and often has a bluish tinge. The cementite remains white.

If the treatment be carried out without using solution 1, the cementite and solid solution remain white. After continued action of solution 4 the cementite becomes yellow to light-brown and the phosphide dark-brown, whereas the solid solution remains white.

The ternary phosphide eutectic was found in cast irons containing more or less undecomposed eutectic cementite, and in irons the structure of which consisted of coarse graphite, pearlite and some ferrite. In the latter irons, however, the tendency of the cementite to decompose was rather great, so that in many parts of the structure the eutectic was present only in the binary form. In cast irons consisting of coarse or fine graphite and ferrite with little, if any, pearlite, only the binary eutectic was found. The decomposition of the cementite causes the solid solution to increase in quantity, according to the two reactions:—

$$Fe_3C \rightarrow 3Fe + C.$$

$$Fe_3C \text{ (not yet decomposed)} + Fe \rightarrow \text{solid solution}$$

$$Fe_3C \rightarrow \text{solid solution} + C$$

Larger areas of solid solution still show the pearlitic structure. But graphitisation can also take place in the solid solution to such an extent that the pearlitic structure disappears, so that it is very difficult to distinguish them from cementite. As long as one is not yet familiar with the results of the new etching reagent it is best practice, in such cases, to judge from the appearance of the entire structure whether cementite may be present or not. This is not the case when the greater part of the structure consists of ferrite. The binary phosphide eutectic in an iron subjected to heavy graphitisation must be etched very carefully. The phosphide often takes a somewhat less dark colour, which is not deepened by repeated etching, but may even fade. In cast steel only the binary eutectic was found, consisting of phosphide and small pearlitic areas.

Mr. Lewis Chapman, managing director of Messrs. William Jessop & Sons, Limited, steel manufacturers, Sheffield, condemned indiscriminate price-cutting in the steel industry when speaking at the annual dinner and prize distribution of the firm's Brightside Works Ambulance Corps recently. It was the sort of competition which nobody wanted, he said, and which had done Sheffield a great deal of harm. It established a false basis, and ultimately reacted to lower the standard of perfection which should be attained in the industry.

* "Die Giesserei" 1933, Nos. 51/52.

XUM

Poor Outlook for Lead

By "ONLOOKER"

In spite of the fact that consumption of lead is being maintained at a favourable level the course of prices recently has been unfavourable, although some improvement has certainly been seen in the last few weeks. As a matter of fact the metal has never held up its head since the lead pool was dissolved in the early part of 1931, after the duty of 10 per cent. had been levied on foreign metal, and although in June last year, under the spur of inflationary enthusiasm in the States, the quotation improved materially, all the ground thus gained has since been lost.

Some measure of restriction on production appears to be in force, but there is no concerted action by producers, and in consequence the statistical position has deteriorated rather badly. At the existing low level of prices it might have been thought that curtailment would have operated naturally, for the return must be very lean, but lead is, of course, very much a by-product and can be sold as such. In market parlance this metal "looks cheap," for although the decline in spelter has to some extent narrowed the margin, lead is still quoted about £3 10s. below zinc, which is at least 30s. more than it ought to be. Of the two metals it is probably right to say that on the consumption side lead can show a healthier position than spelter, and if the former could boast of an organisation similar to the zinc cartel, then we should not see the price where it is. Unquestionably the duty, although reserving this country for the Empire producers, has upset matters on the Metal Exchange, for owing to fears of being landed with a warrant for foreign lead, buyers are reluctant to operate, while on the other hand downward pressure is exercised through sales by European producers who ship their lead to this country for internment in bonded warehouse. In fact, in lead, and in spelter too for that matter, London is no longer a free market and values have suffered.

It is satisfactory to note that Germany's consumption of non-ferrous metals is on the upgrade, for she is a very large consumer of lead, coming, after the United States and Great Britain, third in the world's list of users of this metal. In 1932 her consumption was no more than 121,000 tons, the worst year recorded since 1924 and not much more than half Great Britain's total, so that there is considerable room for improvement, and a return to the levels of 1927, 1928 and 1929 when the figure topped 200,000 tons per annum would go a long way towards improving the outlook for lead and, incidentally, the price! A rate of consumption at that level cannot, however, be visualised just yet, but it is at least something that the outlook across the North Sea is better than it was. In Britain lead usage normally exceeds 250,000 tons per annum, but the 1932 figure was not much more than 220,000 tons.

Although our market in this country is reserved for the Empire producers, there cannot be any fears of a shortage, for between Canada, Australia, Burma and Africa can easily keep us going. In 1932, for example, a year in which production of lead all over the world was fairly drastically cut down, these four countries between them turned out nearly 400,000 tons, whereas our consumption in Britain, as mentioned above, was not much more than half this. Yes, there is certainly plenty of lead for all comers, and it is not wonderful that the metal is being sold at such a poverty-stricken price level, with very little to hope for in the way of improvement unless some major inflationary movement in the States should take place and operate to lift all commodity values. Another alternative is co-operation by the mining interests outside the United States (where lead is protected by a tariff) towards an agreed degree of curtailment, but of this there seems to be very little prospect at present.

Modern Producer-Gas Practice

PROBLEMS OF DUST AND TAR SEPARATION

By OUR ENGINEERING CORRESPONDENT

It is well known that producer gas is more generally used in the metallurgical industries in the hot and dirty condition. This, of course, has the advantage that most of the sensible heat is utilised, but the disadvantage of a heavy dust content, especially when using the latest modern types of completely mechanical producer. In many cases, however, the producer-gas plant has to be a considerable distance from the furnace settings, and in these circumstances there is not only considerable deposition of dust but, much worse, air cooling and separation of objectionable tar.

In this event the best practice is to cool and clean the producer gas, the loss of the sensible heat being more than compensated for by the saving of the trouble involved in cleaning large pipe circuits and valves, sometimes by burning out the deposited dust and tar, and also the inefficiency of burners due to local stoppages by dust or tar.

Further, cool and clean producer gas enables automatic temperature control by thermostats to be installed at the furnace, this being difficult with dirty gas because of the stoppages in the burner equipment.

In this connection of great interest is the electrostatic method of purification, especially in view of the advances that have been made in recent years in the "Lodge-Cottrell" system, due to the active co-operation and the pooling of patents and experience by the respective companies in Great Britain (Lodge-Cottrell, Limited, George Street Parade, Birmingham), Germany and the United States. Thus the total energy consumption is now only about 7-8 kw. per 1,000,000 cub. ft. of producer or similar gas, with a figure of 99.5 per cent. dust removal efficiency or over, irrespective of the size of the dust particles, that is, even when these are below 10 microns, while attendance charges and maintenance costs are negligible.

It is possible to separate the dust direct from the hot, dirty producer gas (containing, of course, no separated tar), since electrostatic methods will operate almost irrespective of any temperature that is reasonably likely. The capital cost of the necessary electrostatic treaters for hot producer gas is, however, greater, since hot gas has an extremely large volume, necessitating, therefore, bulky equipment. Also, under relatively high-temperature conditions the time required for the separation of dust is somewhat greater than in the ordinary cold conditions, which again increases the size of the equipment. It should be pointed out, however, that with very large producer-gas plants these difficulties are not of so much importance as in the case of a small- or medium-sized installation.

When producer gas is cooled, resulting in the deposition of tar, there is no question that the most scientific method is to instal cooling and electrostatic separation plants so as to give a clean gas entirely free from dust, preceded by the ordinary types of water-cooled condensers and scrubbers. In addition to the general advantage of dealing with a much reduced volume, all the water particles are also removed, which improves the combustion efficiency of the gas.

Incidentally, it may be stated that cyclone separation or similar mechanical methods will only result in the removal of the coarser particles from producer gas, and are of little use in dealing with the fine material, especially when below 10 microns in size.

The basic principle of the "Lodge-Cottrell" system, it will be remembered, is the use of plates or pipes, constituting a series of earthed collector electrodes. In the narrow spaces be-

(*Concluded in next column*)

Notes from I.B.F. Branches

Junior Section, Lancashire Branch.—Members of the Junior Section of the Lancashire Branch of the Institute of British Foundrymen held their January meeting in the College of Technology, Manchester, on January 27. Mr. A. L. Key, of Stockport (Vice-President), occupied the chair in the absence of the President, Mr. R. A. Jones.

A Paper entitled "Crucible Melting Furnaces" was given by Mr. G. L. Cassidy, of London. The Paper, which was delivered in an informal way and well illustrated by lantern slides, commenced with an early history of metal-melting and a description of the furnaces used and of how the early founders discovered that their products were improved by keeping the metals being melted from actual contact with the fuel. This led to the introduction of the crucible and the development of the crucible from the early clay to the latest rapid-melting plumbago type. Next came the question of furnace development, commencing with the pit fire and of the cokes available for use, the various analyses, grades, prices and suitable types.

The life of a crucible used in pit fires was discussed, how the life of a crucible was considerably shortened by abuse, such as by allowing metal to stew, by bad furnace design, perishing, and by mechanical damage through bad handling. The author gave some prices and examples. The crucible furnace, its development and its industrial application were described, and the methods of operation and different fuels used in the different types were explained. Some recent installations were instanced.

A vote of thanks was proposed by MR. A. PHILLIPS, President of the Senior Section, and seconded by MR. R. YEOMAN. A good discussion took place afterwards.

Modern Producer-Gas Practice

(*Concluded from previous column*)

tween these plates, or in the pipes hang wires or rods with numerous points, forming discharge electrodes, which are coupled to very high-tension direct-current supply at 60,000-70,000 volts, so that brush discharge takes place. As a result, the dust particles in the gases which pass through the ducts or pipes, are electrified, and repelled against the earthed collector electrodes, which are equipped with motor-driven rapping hammers.

This method is also being widely adopted for many other applications, and over 3,000 electro-filters are at work in Great Britain and Europe, in many different applications, including, for example, blast-furnace gas, coke-oven gas, town's gas, metallurgical and ore-roasting furnaces of all kinds, cement works and steam-boiler plants especially with pulverised-fuel firing.

Chemical Analysis of Steels

Several Papers in the "Chemische Zeitung" deal with the estimation of metals in alloy steels. For the routine estimation of manganese by the Lang-Kurtz method, in conjunction with Si estimation in cast iron by the Cotti method, the manganese is oxidised in a mixture of hydrofluoric and phosphoric acids with bichromate and arsenite and then titrated with ferrosulphate. Another Paper, by K. SWOBODA, deals with the estimation of P in non-alloy and alloy steels and in pig-iron, in the presence or absence of the principal other elements usually found. W. BRÜGGEMANN deals with the estimation of Mo in high-speed and special steels with the simultaneous determination of high copper contents, the Mo being estimated as lead molybdate and the copper by the KCN method. Analysis takes 3 hrs. for Mo and 1 to 2 hrs. for Cu, the accuracy of Mo determination being ±0.02 per cent., and for very high contents ±0.5 per cent. of Mo.

This Week's News in Brief

Trade Talk

MEMBERS OF THE Middlesbrough branch of the Institute of British Foundrymen paid a visit to the works of the Cargo Fleet Iron Company, Limited, recently.

MESSRS. DORMAN, LONG & COMPANY, LIMITED, Middlesbrough, have secured an order from the Dutch Government for 2,800 tons of "Chromador" steel for structural purposes.

THE FIRM OF Messrs. R. & A. Main, Limited, Gothic Iron Works, Falkirk, held their annual Burns Supper in Falkirk on January 26, when Mr. C. M'Lean presided over a large gathering.

MANY UNEMPLOYED MEN will be taken on for some months as a result of a contract which Messrs. R. Y. Pickering & Company, Limited, Wishaw, have secured from the L.M.S.R. Company for twenty vestibuled third-class brake carriages.

AN ORDER FOR A STEAMER of 3,000 tons deadweight has been placed with Messrs. S. P. Austin & Son, Sunderland, by Messrs. William France, Fenwick & Company, Limited, London. The same owners ordered a collier of 4,000 tons deadweight from Messrs. Austin in December last.

THE JOINT SECRETARIES of the Scottish Manufactured Iron Trade Conciliation and Arbitration Board have been informed by the auditor, Sir John M. McLeod, that an examination of the employers' books for the months of November and December, 1933, has shown the average net selling price to be £9 15s. 11.26d. This means that the workers' wages will remain unchanged.

MESSRS. DORMAN, LONG & COMPANY, LIMITED, have started an additional steel furnace at their Britannia works. Within the past few weeks the firm have blown in two more blast furnaces at their Redcar works, while at the beginning of the month a battery of coke ovens was brought into commission at Redcar. Two blast furnaces at the firm's Newport works are being prepared for operation.

AN IMPORTANT FUSION is taking place in the Rumanian iron and engineering industry, the Resicza, the Titan-Nadrag-Calan, and the Copsa-Mica-Cufir works having signed an agreement for community of interest. The Rumanian State is interested in the fusion, and will give big contracts for the supply of locomotives and other railway material, construction steel for bridges, etc., to the combined concerns.

THE DUKE OF YORK, as President of the Industrial Welfare Society, visited the Battersea Works of the Morgan Crucible Company, Limited, on January 30. He donned overalls and spent an hour or more watching the process in the manufacture of plumbago crucibles and other products and heat-resisting ware. The Duke of York was conducted on his tour by Mr. W. F. Coaker and Mr. G. W. Edward, directors of the firm; Mr. S. C. Ramsay, works manager; and Mr. Robert R. Hyde, director of the Industrial Welfare Society.

THE ADMIRALTY ANNOUNCE that, subject to the settlement of certain points of detail, the construction of the following vessels of the 1933 naval programme has been entrusted to the shipbuilders indicated:—One cruiser (H.M.S. "Penelope") to Messrs. Harland & Wolff, Limited, Belfast; one submarine (H.M.S. "Narwhal") to Messrs. Vickers-Armstrongs, Limited, Barrow-in-Furness; one sloop minesweeper (H.M.S. "Speedwell") to Messrs. W. Hamilton & Company, Limited, Port Glasgow, with machinery by Messrs. W. Beardmore & Company, Limited, Dalmuir.

AT THE ANNUAL DINNER of the Steel, Peech & Tozer Works Council, held at the Ickles, Rotherham, on Friday, January 26, Mr. A. Williamson (general manager) said that they were going to get that week the biggest tonnage from the cogging mill they had ever had in the history of the firm. The output for the week should be something over 13,000 tons. Mr. R. Dunkerley (comptroller of the United Steel Companies, Limited) said that United Steels in 1929 was responsible for 12½ per cent. of the ingot production of the country; in 1931 during the depression it rose to 14 per cent., and last year it rose to 16 per cent. Wages paid in their works were nearly 50 per cent. more than they were this time last year.

MR. A. N. MCQUISTAN, general manager of the South Durham Steel & Iron Company, Limited, in an interview recently emphasised the benefit to the British shipbuilding industry of the agreement reached between the British Steel Export Association and the European steelworks by which it was hoped to equalise prices in neutral markets of shipbuilding materials. He said that although the agreement had not yet been signed it had been operating since the beginning of this year. Hitherto British shipbuilders had been handicapped by the ability of the Continental steelmakers to quote more advantageously to the Continental shipbuilders. Now the British shipbuilder would be in a much better position to compete with his Continental rivals.

ORDERS TO THE VALUE of about £3,000,000 were placed with Clyde shipbuilders during January. This encouraging start to a new year follows on a gradual improvement over several months, and appears to justify the belief that the industry is now on the mend. The new contracts comprise mainly Admiralty work. The mercantile tonnage ordered is also fairly substantial, and has been well distributed over the yards. At the beginning of 1933 over 50 per cent. of the Clyde yards had absolutely no work, but at the present time only some half-dozen yards are in that unfortunate position. It is probable that further new work will be forthcoming for the Clyde district in the near future, as there are a number of inquiries for tanker tonnage in circulation.

THE ELEVENTH INTERNATIONAL ACETYLENE CONGRESS will be held in Rome this year from June 5 to 10, and judging from the increasing interest shown in the use of acetylene, and particularly in the improved methods of welding and cutting, there will be an important gathering of interested people from all parts of the world. The number and quality of the papers to be presented by eminent scientists, and the discussions which will ensue, constitute a great attraction. A programme of proceedings and further particulars may be had on application to the British Acetylene Association, 12, Russell Square, London, W.C.1, or the Acetylene & Welding Consulting Bureau, Limited, 638, Grand Buildings, Trafalgar Square, London, W.C.2. The last date for receiving papers is March 31. A session is to be devoted to the technique and applications of acetylene welding and cutting.

Contracts Open

London, E.C., February 23.—C.I. pipes, etc., for the Metropolitan Water Board. The Offices of the Board (Room 155), 173, Rosebery Avenue, E.C.1.

London, S.W., February 9.—Steel wheels and axles, for the South Indian Railway Company, Limited, 91, Petty France, Westminster, S.W.1. (Fee 10s.)

Manchester, February 12.—Lamp columns, for the Electricity Committee. Mr. H. C. Lamb, chief engineer and manager, Electricity Department, Town Hall, Manchester.

Manchester, February 13.—Iron and steel stores, for the Corporation. The General Manager, Corporation Transport Department, 55, Piccadilly, Manchester.

Middleham, February 14.—Supply and laying of 120 yds. of 2-in. dia. cast-iron pipes, with valves, for the Leyburn Rural District Council. The Sanitary Inspector's Office, Market Place, Leyburn, Yorks.

Pontyates, February 16.—Supply and laying of 800 yds. of 4-in. and 2,200 yds. of 3-in. bitumen-lined steel pipes, and 1,600 yds. of 3-in. dia. cast-iron pipes, with valves, etc., for the Carmarthen Rural District Council. The Surveyor, 15, Spilman Street, Carmarthen.

Martensite in Air-cooled Low-Alloy Steels

O. W. MCMULLAN in the "Transactions of the American Society for Steel Treating" reports that in various low-alloy wrought steels, particularly those containing approximately 0.15 per cent. C, 0.25 per cent. Si, 0.45 per cent. Mn, 0.015 per cent. P, 0.03 per cent. S, 1.75 per cent. Ni and 0.25 per cent. Mo, martensite is formed when the steels are air-cooled especially at a temperature near the Ar_1 point. These martensite nuclei are responsible for the restricted durability of tool steels and for the bad surface finish produced by them. The exact cause of the formation of the nuclei is not apparent, but rapid cooling to the Ar_1 point and slower cooling after this point is passed has been found to impede martensite formation.

Obituary

MR. ALEXANDER RANKING, whose death occurred at Durban, Natal, was 45 years of age, and a native of Larbert. He left Scotland in 1911 to take up a position with the Falkirk Iron Company, Limited, at Wentworth.

MR. W. F. CLEMENT, chief engineer of the Barrow Steel Company, Limited, who died last week, was a native of Waterside, Ayrshire. Before joining the Barrow Company he was on the staff of the Blaenavon Steel Company, Monmouthshire. He was 60 years of age.

MR. JOHN PATERSON CROSBIE has died at his residence, Standfield House, Sheffield. He had been associated with Messrs. Hadfields, Limited, for more than 40 years, and joined the board in 1914. He retired from active management two years ago owing to ill-health.

MR. THOMAS ROGERS, of Brownlow Road, Ellesmere, has died at the age of 72. For some years he was at the iron foundry of Messrs. William Clay & Sons, and in 1910, on the death of Mr. William Clay, he assumed control of the foundry and also the Victoria Foundry at Oswestry.

A WELL-KNOWN SCOTTISH IRONFOUNDER, Mr. John Steel, proprietor of Boness Foundry, has died at Stramore, Uddingston (Lanark). A native of Boness, Mr. Steel served as an engineer in Newcastle. Returning to Boness, he succeeded to his father's foundry business at the age of 30.

WE REGRET TO ANNOUNCE the death, after a short illness, of Mr. Henry White, chairman of W. Pickard & Company, Limited, Saxon Works, Rutland Road, Sheffield. Mr. White was chairman of the company from the time of its formation to the beginning of January, when he resigned owing to the condition of his health.

THE DEATH OCCURRED, at his home in Kilmarnock, on January 28, of Mr. James Johnston, draughtsman with Messrs. Glenfield & Kennedy, Limited. Mr. Johnston, who was 56 years of age, was seized with illness, and died before medical aid could be obtained. He was a native of Kilmarnock, and son of the late Mr. Robert Johnston, who was for many years leading draughtsman with Messrs. Glenfield & Kennedy.

THE DEATH OCCURRED, at his residence in Netherton, near Wishaw, on January 30, of Mr. James Jarvie, foreman smith with the Glasgow Iron & Steel Company, Limited. Mr. Jarvie, who was in his 82nd year, was a native of Coatbridge. He served his apprenticeship with Messrs. R. Baxter and later was in the employment of Messrs. Shearer & Pettigrew and of Messrs. R. Y. Pickering & Company, Limited, Wishaw.

Personal

MR. A. E. L. CHORLTON, M.P., has been elected a director of Lancashire Dynamo & Crypto, Limited.

MAJOR-GENERAL THE RT. HON. SIR FREDERICK HUGH SYKES has been elected a director of Messrs. Callender's Cable & Construction Company, Limited, and of the Anchor Cable Company, Limited.

MR. AND MRS. ARCHIBALD MURDOCH, 6, Townhead, Kirkintilloch, have just celebrated their diamond wedding. Mr. Murdoch was for 52 years with the Lion Foundry Company, Limited, as a patternmaker. He is 83 years of age and his wife is 79.

THE STAFF OF David Brown & Sons (Huddersfield), Limited, engineers, foundrymen and gear specialists, met at dinner on the evening of February 2 to honour Mr. F. L. Brown, governing director, on his attaining his forty-fifth year with the company. In the course of the evening Mr. Brown was presented with his portrait in oils, painted by Mr. John A. A. Berris, of Liverpool.

MR. P. J. H. HANNON has been appointed deputy-chairman of the Birmingham Small Arms Company, Limited. Mr. Geoffrey Duke Burton has been appointed managing director, and Mr. A. E. Berriman has been elected a director and appointed assistant managing director. Mr. Percy Martin, who is shortly relinquishing the office of managing director of the company, has been elected chairman of the Daimler Company, Limited. He will, however, remain a director of the Birmingham Small Arms Company.

Will

EYRES, JOHN, of Messrs. J. & S. Eyres, Limited, ironfounders, Miles Platting, Manchester £6,313

XUM

Raw Material Markets

Iron and steel materials are generally in strong demand. The call for some grades of pig-iron exceeds the supply, and speculative purchases are being discouraged by the makers. The question of increases in iron prices has been shelved for the time being, but the market preserves a very strong tone.

The scheme for the reorganisation of the British iron and steel industry is now in an advanced form. It will be presented at the annual meeting of the National Federation of Iron and Steel Manufacturers in London on February 22.

Pig-Iron

MIDDLESBROUGH.—In spite of the increases being made in production in this area, there is still a temporary shortage of iron on the market. The makers are so heavily committed that they cannot accept further orders, and business is therefore in a state of suspense. For the time being, they have decided to make no alteration in the official scale of prices. It is to be noted, however, that these are minimum prices, and it is understood that in some cases more has been paid. The official quotations are:—No. 3 Cleveland G.M.B., 62s. 6d. per ton delivered Middlesbrough area, 64s. 6d. per ton delivered North-East Coast, 62s. 3d. delivered Falkirk.

What stocks still remain of East Coast hematite are being rapidly reduced. Further substantial contracts have been entered into with steel firms in South Wales and the Midlands, based on the official price of 62s. 6d. per ton f.o.t. makers' works. Little export business is being done.

LANCASHIRE.—The pig-iron demand in this area is, perhaps, slightly less active, but this was expected after the large amount of business recently transacted with the consuming works. The latter maintain their activity fairly satisfactorily. For delivery to users in the Manchester zone, current offers of Derbyshire, Staffordshire and North-East Coast brands of No. 3 foundry iron are on the basis of 67s. per ton, with Northamptonshire quoted at 65s. 6d., Derbyshire forge at 62s., Scottish foundry at around 80s., East Coast hematite at about 76s. 6d., and West Coast at between 80s. and 81s.

MIDLANDS.—In spite of the recent buying, there is still a good demand for pig-iron, particularly from the light-castings trade. Northants producers have little iron to sell, however, but a fairly large amount of Derbyshire iron is still available. The minimum Association rates for ordinary iron delivered to this district are 62s. 6d. for Northants No. 3 and 66s. for Derbyshire. Lincolnshire and North Staffordshire No. 3, plus 7d. extra for delivery into works where required, and subject to rebate for large consumers. There is a fair demand from this district for special irons for the engineering trade, the prices of which are without control and thus vary considerably according to quality, tonnage and source. Scottish pig-iron is from 82s. 6d. to 85s., low-phosphorus iron from 80s. to 85s., and medium-phosphorus 70s. to 80s. Special refined irons for Diesel-engine and similar work are quoted at £5 15s. to £6 15s. per ton.

SCOTLAND.—The pig-iron market is generally stronger, but the demand from the heavy foundries is still slow to improve, and there is not more than a "steady" demand for Scottish iron at 65s. for No. 3 foundry, at furnaces, with 2s. 6d. per ton extra for No. 1. The foundries in the Falkirk area continue very busy and are making urgent calls for supplies of English iron. Middlesbrough No. 3 is still officially quoted at 62s. 6d. at Falkirk and 65s. 3d. at Glasgow, but it has not been possible for users to buy at these levels for some time.

Coke

The foundry-coke market has a strong tone at the moment and prices have a tendency to rise. Present quotations, delivered in the South Staffordshire area, are as follow:—Best Durham foundry coke, 36s. 6d. to 40s.; Welsh coke, 35s. to 47s.; Scottish low-ash coke, 39s. 6d. per ton.

Steel

Active trading conditions rule in the steel markets and prices in several departments have a tendency to rise. In the semi-finished steel department there has been some relaxation in the demand and the producing works have been able to overtake deliveries. For the most part the business transacted has been confined to small parcels, the important consumers having covered their requirements for some time ahead. There have been few offerings of Continental semis in the British market and the movement of the exchange has proved an additional handicap to business in foreign steel, as it has increased prices by some shillings. In the finished-steel department, active conditions prevail at most of the works; but there has been a slight decrease in the volume of business transacted. This, however, is regarded merely as a temporary lull. Export business is difficult, but there is still a good demand from the home market.

Scrap

The Cleveland scrap-iron market maintains a firm tone, prices being unchanged at 53s. 6d. and 55s. per ton for heavy metal and machinery metal respectively. There continues to be a steady demand in the Midlands, quotations remaining at 55s. delivered for heavy machinery, 50s. for good heavy metal and 42s. 6d. for clean light metal. The foundries in Scotland are also showing a keener interest in scrap iron, following upon the scarcity of new material. In South Wales, increased prices have been recorded. Heavy cast iron, in large pieces and furnace sizes, is now at 50s. per ton and light cast-iron scrap at 40s. to 42s. 6d. There is not such a good demand for machinery scrap, which is quoted at about 50s. per ton.

Metals

Copper.—There has not been more than a limited demand from consumers lately, and the market has been largely under the influence of currency movements and the general financial uncertainty. Considerable hesitation has been shown, but quotations nevertheless advanced to £34 per ton on Tuesday for standard metal. Dealing on the market is still largely of a speculative nature, as manufacturers are inclined to await a clearer outlook before buying any quantity, and are therefore restricting purchases to their immediate needs.

The week's prices have been as follow:—

Cash.—Thursday, £33 5s. to £33 6s. 3d.; Friday, £33 11s. 3d. to £33 12s. 6d.; Monday, £34 to £34 1s. 3d.; Tuesday, £34 to £34 1s. 3d.; Wednesday, £33 12s. 6d. to £33 13s. 9d.

Three Months. — Thursday, £33 7s. 6d. to £33 8s. 9d.; Friday, £33 15s. to £33 16s. 3d.; Monday, £34 3s. 9d. to £34 5s.; Tuesday, £34 3s. 9d. to £34 5s.; Wednesday, £33 16s. 3d. to £33 17s. 6d.

Tin.—Offerings of metal for near delivery have been comparatively light, and in consequence the "backwardation" has inclined to increase, at one time amounting to 15s. The statistics published last Thursday showed a net decrease in the total visible supply—including the carry-over in the Straits—of 1,069 tons; the figures were not quite so good as had been anticipated, but their publication had no appreciable influence on the course of prices. Demand on the part of consumers in this country and on the Continent is fairly well maintained, but in the United States of America inquiry has been on a reduced scale and business is reported quiet. Market conditions generally show no appreciable change: the undertone remains firm, and steady conditions seem likely to prevail pending more definite indication—particularly with regard to America—as to how the industrial situation will develop and how markets will react to the schemes which have recently been formulated, state Messrs. Rudolf Wolff in their weekly report.

Daily quotations:—

Cash.—Thursday, £226 10s. to £226 15s.; Friday, £226 10s. to £226 12s. 6d.; Monday, £227 7s. 6d. to £227 10s.; Tuesday, £227 7s. 6d. to £227 10s.; Wednesday, £226 15s. to £227.

Three Months.—Thursday, £225 17s. 6d. to £226; Friday, £226 to £226 2s. 6d.; Monday, £226 12s. 6d. to £226 15s.; Tuesday, £226 12s. 6d. to £226 15s.; Wednesday, £226 to £226 5s.

Spelter.—The zinc market has maintained a fairly firm tone. Nevertheless, prices have shown a slight weakness following upon news that a number of shipments of foreign spelter are due to arrive here this month. Although there is a tariff on non-Empire imports, the latter nevertheless have an adverse effect upon market prices.

Price fluctuations:—

Ordinary.—Thursday, £14 12s. 6d.; Friday, £14 16s. 3d.; Monday, £14 16s. 3d.; Tuesday, £15 1s. 3d.; Wednesday, £14 17s. 6d.

Lead.—Messrs. Brandeis, Goldschmidt report that "the expected improvement in industrial conditions is taking place more slowly than had been hoped, and the volume of new orders which have been taken by consumers is only moderate. The American currency experiments are not being felt so much in the lead market in Europe. It is possible, however, that in the U.S.A.—where the price has so far remained unchanged—there might be a stimulus to production greater than any increase in the purchasing power of consumers. This tendency was evident towards the end of last year and the figures for January will be awaited with interest."

Daily market prices:—

Soft Foreign (Prompt).—Thursday, £11 7s. 6d.; Friday, £11 12s. 6d.; Monday, £11 15s.; Tuesday, £11 16s. 3d.; Wednesday, £11 13s. 9d.

Students Corner

Q.—What should be the weight of the metal charges in the cupola in relation to diameter of cupola?

A.—In many instances the weight of metal and coke charges are too heavy, and in practice the best results are obtained with small charges. For uniform and continuously good conditions for melting, the smaller the charges the better will be the results. If the correct amount of metal, coke and flux are mixed together so much the better. With many self-charging or mechanically-charged cupolas this is done. The whole charge of metal scrap and limestone is put into the skip and dropped into the cupola. The maximum weight of charges comprising the pig and scrap are submitted and borne out in practice as follows:—

For cupolas	24 in.	dia.,	6	cwts.
,,	36	,,	12	,,
,,	48	,,	20	,,
,,	60	,,	25	,,
,,	72	,,	30	,,

Q.—What is the difference between the two air-pressure gauges in use in cupola practice?

A.—They are the mercury and water gauges. Mercury is the only metal which is liquid at ordinary temperatures. It has a specific gravity of 13.595. If a small extension pipe is connected with the main blast pipe, the blast then applied, the force of blast that would raise the mercury in the glass tube 1 in., would force water 13.595 in. This is due to the specific gravity of the liquids. Mercury being 13.595 times as heavy as water. Some equivalents are as follow:—

1 oz. per sq. in.				= 1.725 in.	water gauge.
8	,,	,,	,,	= 13.800	,,
9	,,	,,	,,	= 15.500	,,
10	,,	,,	,,	= 17.250	,,

12 in. on the water gauge = 0.443 oz. on the mercury gauge.

One pound per sq. in. pressure = 27 in. head of water, or 2.03 in. head of mercury.

One oz. per sq. in. = 1.73 in. water.

One in. of water = 0.578 oz. per sq. in.

One ft. of water = 0.433 lb. per sq. in.

One in. of mercury = 0.4905 lb. per sq. in.

One in. of water = 0.578 oz. per sq. in., therefore 0.578 by 13.595 = 7.85, which gives the ounces that one inch of mercury will equal.

Q.—What is the requisite amount of air per ton of iron melted?

A.—About 30,000 cub. ft.

MESSRS. LITHGOWS, LIMITED, Port Glasgow, have secured an order for a steamer for the British Phosphates Commissioners, London. The vessel will be of about 5,000 gross tons.

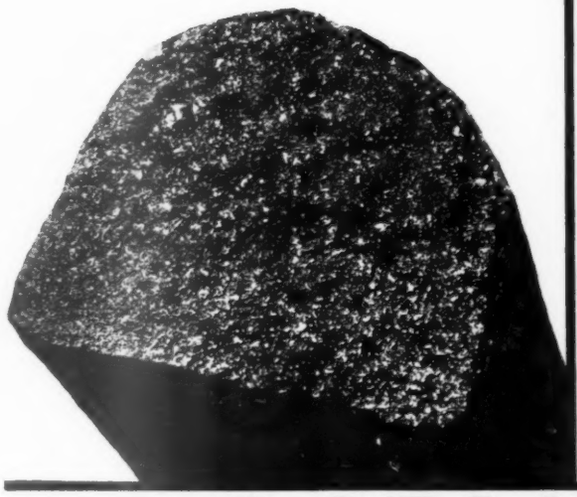
F.T.J. 8.2.34.

ENDURANCE

For forty years the statue of "Eros," erected in Piccadilly Circus as a memorial to the 7th Earl of Shaftesbury, has demonstrated the enduring qualities of aluminium alloys. During that period developments in light alloys have grown apace, until to-day a series of metals is available giving a wide range of properties from which to choose for the purpose which the metal must serve.

BA ALUMINIUM AND LIGHT ALLOYS
The BRITISH ALUMINIUM CO. Ltd.
HEAD OFFICE: ADELAIDE HOUSE, KING WILLIAM ST., LONDON, E.C.4.
TELEPHONE: MANSION HOUSE 5561 & 8074 (5 LINES) TELEGRAMS: CRYOLITE, BILGATE, LONDON.

The BRITISH ALUMINIUM COMPANY Ltd.



PIG IRON

Manufacturers of FOUNDRY, BASIC and HEMATITE qualities. Delivery from stock. Booklet giving analyses, etc., will be sent on request.

DORMAN LONG

DORMAN LONG & CO. LTD., MIDDLESBROUGH

RAW MATERIALS—PRICE LIST

(Wednesday, February 7, 1934)

COPPER

	£	s.	d.
Standard cash	33	12	6
Three months	33	16	3
Electrolytic	36	10	0
Tough	35	10	0
Best selected	36	0	0
Sheets	64	0	0
India	45	5	0
Wire bars	37	0	0
Ingot bars	37	0	0
H.C. wire rods	39	5	0
Off. av. cash, January	32	12	0 9/11
Do., 3 mths., January	32	14	8 21/22
Do., Sttlmnt., January	32	12	1 19/22
Do., Electro, January	35	18	6 5/11
Do., B.S., January	35	9	8 3/11
Do., wire bars, January	36	4	9 3/11
Solid drawn tubes			10d.
Brazed tubes			10d.
Wire			6½d.

BRASS

Solid drawn tubes	9d.
Brazed tubes	11d.
Rods, drawn	8½d.
Rods, extd. or rlld.	4½d.
Sheets to 10 w.g.	7½d.
Wire	7½d.
Rolled metal	7d.
Yellow metal rods	4½d.
Do. 4 × 4 Squares	5½d.
Do. 4 × 3 Sheets	5½d.

TIN

	£	s.	d.
Standard cash	226	15	0
Three months	226	0	0
English	227	10	0
Bars	229	0	0
Straits	231	0	0
Australian (nom.)			—
Eastern	230	0	0
Banca	231	5	0
Off. av. cash, January	226	14	3 9/11
Do., 3 mths., January	226	15	8 2/11
Do., Sttlmt., January	226	14	1 1/11

SPELTER

	£	s.	d.
Ordinary	14	17	6
Remelted	15	0	0
Hard	12	5	0
Electro 99.9	17	10	0
English	15	15	0
India	14	10	0
Zinc dust	20	0	0
Zinc ashes	3	5	0
Off. aver., January	14	16	3 15/16
Aver. spot, January	14	13	9

LEAD

	£	s.	d.
Soft foreign ppt.	11	13	9
Empire	12	1	3
English	13	0	0
Off. average, January	11	8	2 23/24
Average spot, January	11	6	0 23/24

ALUMINIUM

Ingots	£100 to £105
Wire	1/1 to 1/9 lb.
Sheet and foil	1/2 to 2/9 lb.

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	24	10	0
Do., V.M. ex whse.	23	5	0
Rods	28	15	0

ANTIMONY

	£	s.	d.	£	s.	d.
English	37	10	0 to	40	0	0
Chinese, ex-whse.				26	10	0
Crude				20	0	0

QUICKSILVER

	£	s.	d.	£	s.	d.
Quicksilver	10	2	6 to	10	12	6

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—	
25%	£6 10 0
45/50%	£13 0 0
75%	£18 2 6
Ferro-vanadium—	
35 50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% carbon-free of Mo.	5/6 per lb.
Ferro-titanium—	
23/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£14 10 0
Ferro-tungsten—	
80/85%	2/6 lb.
Tungsten metal powder—	
98/99%	2/9 lb.
Ferro-chrome—	
2/4% car.	£32 0 0
4/6% car.	£23 0 0
6/8% car.	£21 12 6
8/10% car.	£21 12 6
Ferro-chrome—	
Max. 2% car.	£36 10 0
Max. 1% car.	£37 10 0
Max. 0.70% car.	£38 15 0
70% carbon-free	10½d. lb.
Nickel—99.5/100%	£225 to £230
"F" nickel shot	£202 10 0
Ferro-cobalt, 98/99%	5/6 lb.
Metallic chromium—	
96/98%	2/5 lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to £11 5 0
76/80% packed	£11 15 0 to £12 5 0
76/80% export	(nom.) £9 15 0
Metallic manganese—	
94/96% carbon-free	1/2 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 1/8 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ¼ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP

	£	s.	d.	£	s.	d.
South Wales—						
Heavy steel	2	15	0 to	2	17	6
Bundled steel and shrngs.	2	7	6 to	2	15	0
Mixed iron and steel	2	10	0 to	2	12	6
Heavy cast iron				2	10	0
Good machinery				2	10	0
Cleveland—						
Heavy steel	2	12	6 to	2	14	0
Steel turnings				1	17	6
Cast-iron borings				1	8	9
Heavy forge				2	10	0
W.I. piling scrap				2	5	0
Cast-iron scrap	2	13	6 to	2	15	0
Midlands—						
Light cast-iron scrap				2	2	6
Heavy wrought iron				2	15	0
Steel turnings, f.o.r.				1	13	6
Scotland—						
Heavy steel	2	13	6 to	2	15	0
Ordinary cast iron				2	15	0
Engineers' turnings				2	1	6
Cast-iron borings				2	0	0
Wrought-iron piling				2	12	6
Heavy machinery				2	17	6

London—Merchants' buying prices, delivered yard.

	£	s.	d.
Copper (clean)	27	0	0
Brass	20	0	0
Lead (less usual draft)	10	15	0
Tea lead	8	0	0
Zinc	10	0	0
New aluminium cuttings	68	0	0
Braziery copper	25	0	0
Gunmetal	25	0	0
Hollow pewter	150	0	0
Shaped black pewter	106	0	0

PIG-IRON

(f.o.t. unless otherwise stated)

N.E. Coast (d/d Tees side area)—	
Foundry No. 1	65/-
Foundry No. 3	62/6
„ at Falkirk	62/3
„ at Glasgow	65/3
Foundry No. 4	61/6
Forge No. 4	61/6
Hematite No. 1, f.o.t.	63/-
Hematite M/Nos., f.o.t.	62/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	70/-
„ d/d Birm.	84/6
Malleable iron d/d Birm.	115/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	62/-
„ No. 3 fdry.	66/-
Northants forge	58/6
„ fdry. No. 3	62/6
„ fdry No. 1	65/6
Derbyshire forge	62/-
„ fdry. No. 3	66/-
„ fdry. No. 1	69/-
Scotland—	
Foundry No. 1	67/6
„ No. 3	65/-
Hem. M/Nos. d/d	66/-
Sheffield (d/d district)—	
Derby forge	59/6
„ fdry. No. 3	63/6
Lincs forge	59/6
„ fdry. No. 3	63/6
E.C. hematite	76/6
W.C. hematite	83/6
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	67/-
Staffs fdry. No. 3	67/-
Northants fdry. No. 3	65/6
Cleveland fdry. No. 3	67/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	80/-
Clyde, No. 3	80/-
Monkland, No. 3	80/-
Summerlee, No. 3	80/-
Eglinton, No. 3	80/-
Gartsherrie, No. 3	80/-
Shotts, No. 3	80/-

FINISHED IRON AND STEEL

Usual district deliveries for iron; delivered consumer's station for steel.

Iron—	£	s.	d.	£	s.	d.
Bars (cr.)	9	0	0 to	9	15	0
Nut and bolt iron	7	0	0 to	7	15	0
Hoops	10	10	0 to	12	0	0
Marked bars (Staffs) f.o.t.				12	0	0
Gas strip	10	10	0 to	12	0	0
Bolts and nuts, ¾ in. × 4 in.				13	15	0
Steel—						
Plates, ship, etc.	8	15	0 to	8	17	6
Boiler plts.	8	5	0 to	8	15	0
Chequer plts.				10	7	6
Angles				8	7	6
Tees				9	7	6
Joists				8	15	0
Rounds and squares, 3 in. to 5½ in.				9	7	6
Rounds under 3 in. to ¾ in. (Untested)	7	12	6 to	8	5	0
Flats—8 in. wide and over				8	12	6
„ under 8 in. and over 5 in.				8	17	6
Rails, heavy	8	5	0 to	8	10	0
Fishplates	12	0	0 to	12	10	0
Hoops (Staffs)	10	10	0 & up.			
Black sheets, 24g. (4-t. lots)				10	5	0
Galv. cor. shts. („)				12	15	0
Galv. flat shts. („)				13	5	0
Galv. fencing wire, 8g. plain				14	0	0
Billets, soft	5	10	0 to	5	15	0
Billets, hard	6	17	6 to	7	2	6
Sheet bars	5	0	0 to	5	10	0
Tin bars				5	0	0

PHOSPHOR BRONZE

	Per lb. basis.
Strip	11d.
Sheet to 10 w.g.	12d.
Wire	11½d.
Rods	11d.
Tubes	15d.
Castings	13d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	19.26
No. 2 foundry, Valley	17.50
No. 2 foundry, Birm.	18.50
Basic, Valley	17.00
Bessemer	19.76
Malleable, Valley	17.50
Grey forge, Valley	17.50
Ferro-mang. 80%, seaboard	85.00
O.-h. rails, h'y, at mill	36.37½
Billets	26.00
Sheet bars	26.00
Wire rods	36.00
	Cents.
Iron bars, Phila.	1.89
Steel bars	1.75
Tank plates	1.79
Beams, etc.	1.70
Skelp, grooved steel	1.60
Steel hoops	1.85
Sheets, black, No. 24	2.25
Sheets, galv., No. 24	2.85
Wire nails	2.35
Plain wire	2.20
Barbed wire, galv.	2.85
Tinplates, 100-lb. box	$5.25

COKE (at ovens)

Welsh foundry	25/- to 30/-
„ furnace	17/6 to 18/-
Durham foundry	21/- to 25/-
„ furnace	18/-
Midlands, foundry	—
„ furnace	—

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes	20×14	per box	16/3 to 16/6
„	28×20	„	32/6 to 33/-
„	20×10	„	23/3 to 23/9
„	18⅞×14	„	16/9 to 17/-
C.W.	20×14	„	14/9 to 14/10½
„	28×20	„	30/9 to 31/-
„	20×10	„	21/9
„	18⅞×14	„	15/3

SWEDISH CHARCOAL IRON & STEEL

	£	s.	d.	£	s.	d.
Pig-iron	£6	0	0 to	£7	0	0
Bars-hammered, basis	£16	0	0 to	£16	10	0
Bars and nail-rods, rolled, basis	£15	15	0 to	£16	0	0
Blooms	£10	0	0 to	£12	0	0
Keg steel	£30	0	0 to	£31	0	0
Faggot steel	£18	0	0 to	£23	0	0
Bars and rods dead soft, st'l	£10	0	0 to	£12	0	0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

		£ s. d.	
Feb.	1 ..	33 5 0	dec. 6/3
,,	2 ..	33 11 3	inc. 6/3
,,	5 ..	34 0 0	,, 8/9
,,	6 ..	34 0 0	No change
,,	7 ..	33 12 6	dec. 7 6

Electrolytic Copper

		£ s. d.	
Feb.	1 ..	36 5 0	dec. 5/-
,,	2 ..	36 15 0	inc. 10/-
,,	5 ..	37 0 0	,, 5/-
,,	6 ..	36 10 0	dec. 10/-
,,	7 ..	36 10 0	No change

Standard Tin (cash)

		£ s. d.	
Feb.	1 ..	226 10 0	inc. 5/-
,,	2 ..	226 10 0	No change
,,	5 ..	227 7 6	inc. 17/6
,,	6 ..	227 7 6	No change
,,	7 ..	226 15 0	dec. 12/6

Tin (English ingots)

		£ s. d.	
Feb.	1 ..	227 0 0	No change
,,	2 ..	227 0 0	,, ,,
,,	5 ..	228 0 0	inc. 20/-
,,	6 ..	228 0 0	No change
,,	7 ..	227 10 0	dec. 10/-

Spelter (ordinary)

		£ s. d.	
Feb.	1 ..	14 12 6	dec. 3/9
,,	2 ..	14 16 3	inc. 3/9
,,	5 ..	14 16 3	No change
,,	6 ..	15 1 3	inc. 5/-
,,	7 ..	14 17 6	dec. 3/9

Spelter (Electro, 99.9 per cent.)

		£ s. d.	
Feb.	1 ..	17 0 0	No change
,,	2 ..	17 5 0	inc. 5/-
,,	5 ..	17 5 0	No change
,,	6 ..	17 10 0	inc. 5/-
,,	7 ..	17 10 0	No change

Zinc Sheets (English)

		£ s. d.	
Feb.	1 ..	24 10 0	No change
,,	2 ..	24 10 0	,, ,,
,,	5 ..	24 10 0	,, ,,
,,	6 ..	24 10 0	,, ,,
,,	7 ..	24 10 0	,, ,,

Lead (English)

		£ s. d.	
Feb.	1 ..	12 15 0	No change
,,	2 ..	13 0 0	inc. 5/-
,,	5 ..	13 0 0	No change
,,	6 ..	13 0 0	,, ,,
,,	7 ..	13 0 0	,, ,,

AVERAGE MONTHLY PRICES OF STEEL BOILER PLATES IN ENGLAND

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1897	6 10 0	6 10 0	6 10 0	6 7 6	6 2 6	6 2 6	6 5 0	6 0 0	6 0 0	6 0 0	6 7 6	6 10 0	6 5 5
1898	6 10 0	6 8 9	6 8 9	6 10 0	6 15 0	6 18 9	6 17 6	6 17 6	7 2 6	6 15 0	7 0 0	7 5 0	6 15 8½
1899	7 5 0	8 0 0	8 2 6	8 2 6	8 5 0	8 5 0	8 12 6	8 12 6	8 15 0	8 15 0	9 2 6	9 5 0	8 17 8½
1900	9 5 0	9 5 0	9 7 6	9 10 0	9 12 6	10 5 0	10 5 0	10 5 0	10 5 0	10 0 0	9 15 0	9 15 0	9 15 10
1901	9 5 0	9 5 0	8 15 0	8 10 0	8 10 0	7 10 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	8 3 11
1902	7 7 6	7 0 0	7 12 6	7 12 6	7 12 6	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 9 7
1903	7 10 0	7 10 0	7 15 0	7 5 0	7 5 0	7 5 0	7 5 0	7 0 0	7 0 0	7 0 0	7 0 0	6 17 6	7 3 11½
1904	6 12 6	6 15 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	6 18 11½
1905	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 10 0	7 5 0	8 0 0	8 0 0	7 1 3
1906	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 10 0	8 0 10
1907	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 0 0	8 0 0	8 8 4
1908	7 10 0	7 10 0	7 10 0	7 5 0	7 5 0	7 5 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 3 9
1909	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	6 15 0	6 15 0	6 15 0	7 0 0	7 0 0	7 0 0	7 0 0	6 18 9
1910	7 0 0	7 0 0	7 1 3	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0	7 10 0	7 10 0	7 10 0	7 5 1
1911	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 14 0	7 10 4
1912	7 18 9	8 0 0	8 0 0	8 7 6	8 10 0	8 10 0	8 10 0	8 15 0	8 16 3	9 0 0	9 2 0	9 5 0	8 11 2½
1913	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	8 19 0	8 15 0	8 5 0	7 15 0	7 15 0	8 17 0
1914	7 15 0	7 15 0	7 15 0	7 13 9	7 10 6	7 5 0	7 0 0	8 0 0	8 2 6	8 5 0	8 5 0	8 5 0	7 15 11½
1915	8 14 0	9 10 0	9 17 6	10 10 0	10 10 0	11 0 0	11 0 0	11 0 0	11 0 0	11 4 0	12 0 0	13 0 0	10 15 6½
1916	13 0 0	13 0 0	13 0 0	12 15 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 12 11
1917	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0
1918	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0
1919	13 0 0	15 0 0	15 0 0	15 0 0	19 5 0	19 17 6	21 0 0	21 10 0	21 10 0	21 10 0	21 15 0	23 10 0	18 9 9
1920	26 0 0	28 0 0	28 5 0	28 10 0	29 5 0	30 0 0	30 0 0	30 0 0	30 10 0	31 0 0	31 0 0	31 0 0	29 9 2
1921	30 5 0	29 0 0	25 0 0	25 0 0	25 0 0	23 0 0	21 0 0	20 10 0	19 0 0	17 10 0	16 0 0	14 16 0	22 1 9
1922	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	13 1 8	13 10 0	12 15 0	12 10 0	12 10 0	12 10 0	12 6 0	13 10 9
1923	12 8 9	13 6 0	14 0 0	14 0 0	14 0 0	14 0 0	13 12 6	13 0 0	13 0 0	13 0 0	13 0 0	13 10 0	13 9 1½
1924	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	14 0 0	14 0 0	13 11 0	13 5 0	13 5 0	13 10 11
1925	13 5 0	13 5 0	13 5 0	13 1 0	12 15 0	12 15 0	12 15 0	12 15 0	12 7 6	11 14 0	11 10 0	11 10 0	12 11 5½
1926	11 15 0	11 10 0	11 10 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 6 3
1927	11 5 0	11 5 0	11 5 0	11 2 6	11 0 0	11 0 0	11 0 0	11 0 0	10 16 0	10 10 0	10 10 0	10 10 0	10 19 0½
1928	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0
1929	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 5 0	10 1 3	10 1 3	10 1 3	10 1 7	10 6 8½
1930	10 2 9	10 3 5½	10 3 9	10 3 9	10 3 6	10 2 6	10 2 6	10 2 6	10 2 2½	9 19 6	9 16 3	9 16 3	10 1 6½
1931	9 15 0	9 15 0	9 15 0	9 10 11	9 6 9	9 5 0	9 7 0	9 7 9½	9 8 9	9 5 9	9 5 6	9 9 6	9 9 4
1932	9 5 0	9 2 6	8 18 6	8 17 6	8 16 6½	8 16 3	8 16 3	8 16 3	8 16 3	8 16 3	8 16 3	8 16 3	8 17 10
1933	8 15 0	8 10 0	8 10 0	8 8 9	8 5 0	8 5 0	8 5 0	8 5 0	8 5 0	8 5 0	8 6 0	8 7 6	8 6 10½
1934	8 8 1½												

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.

13, RUMFORD STREET, LIVERPOOL.

PIG IRON

REGISTERED TRADE MARK LIMPET

All grades FOUNDRY, HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,

CENTRAL CHAMBERS, 93, HOPE ST., GLASGOW, C.2.

ZETLAND ROAD, MIDDLESBROUGH.

SITUATIONS VACANT AND WANTED

TO Ferrous and Non-Ferrous Foundries.—Advertiser desires post as Manager, having had over 18 years' practical, metallurgical and commercial experience; well up in new methods of production and technique of the foundry. Can introduce some regular business; knowledge of accountancy, costing, and capable of taking complete control.—Write, Box 648, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

ADVERTISER, well established among ironfounders with travelling Midland Counties and Lancashire, is desirous of selling pig-iron for a blast-furnace company.—Address, Box 654, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

DEFINITELY-PRACTICAL Foundry Manager, having unrivalled experience in the successful conduct of large ironfoundries, is open for re-engagement.—Box 634, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

A SPLENDID opportunity occurs, in well-known, old-established malleable-iron business, for Working Foundry Foreman, able to take full control. Must have had actual experience in patternmaking, cupola work, stump and machine moulding (small articles), also annealing by gas oven.—Write, stating age, wage, and full particulars of experience, to Box 656, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

PIG-IRON Salesman.—Large Midland firm of pig-iron producers require a Salesman for their foundry and forge irons in London and district.—Replies, with full particulars, to Box 642, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

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